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New Zealand. Geol. survey dept.

REPORTS

OF

GEOLOGICAL EXPLORATIONS

DURING 1870-1,

WITH MAPS AND SECTIONS,

JAMES HECTOR, M.D. F.R.S.,
DIRECTOR.

PUBLISHED BY COMMAND.

NEW ZEALAND.
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THE following Reports contain the information obtained in the course of geological explorations for the Department during the year 1870–1; together with a Paper relative to the Waipara District, read by Dr. Haast before the Canterbury Institute, in December, 1869, and also a short notice, by Captain Hutton, of the discovery of a coal seam in the Waikato District, which is reprinted, for convenience of reference, from the Parliamentary Papers for 1869. The customary review of the progress of the Survey will appear with a geological map of New Zealand, which is in course of Publication.

JAMES HECTOR.

Geological Survey Office,
Wellington, August, 1871.

ERRATA.

Page v., lines 6 and 17, read "E. H. Davis."
„ 24, line 21, for "cakes" read "cubes."
„ 47, line 21, for "Redwood" read "Rockwood."
„ 52, lines 5, 38, and 40, for "Abram" read "Abner."

CONTENTS.

PAGE.

On a Coal Seam discovered on the MARAMARUA CREEK, Waikato. By Capt. F. W. Hutton, F.G.S. 1

On the Geology of COROMANDEL. By Capt. F. W. Hutton, F.G.S. . 2

On the Geology of the WAIPARA District, Canterbury, with Geological Maps and Sections. By Julius Haast, Ph.D., F.R.S. . . 5

Notes on the Geology of the CENTRAL PORTION OF THE ALPS, including Mount Cook. By Julius Haast, Ph.D., F.R.S. . . 19

On the Geology of the AMURI District, in the Provinces of Nelson and Marlborough. By Julius Haast, Ph.D., F.R.S.

- Narrative 25
- Topography 26
- Marlstones 28
- Newer Series 29
- Jurassic Beds 31
- Glacier Action, about 33
- Basalts 34
- Amuri Bluff series 35
- Saurians 36
- Kaikora Peninsula 39
- Mount Caverhill 40
- Cheviot Hills 41
- Icthyosaurus 42
- Gore Bay 42

Titles of Sections, illustrating the Geology of the AMURI District . 42

On the Geological Structure of the MALVERN HILLS District. By Dr. Hector

- Narrative 46
- Rockwood 47
- Rakaia Range 48
- Acheron 49
- Copper Cliff 49
- Knight's Flat 50

Hart's Coal Mine 50
Church Reserve 51
Harper Hills 51
Jebson's Mine 52
Abstract of ANALYSIS OF COAL from the MALVERN HILLS . 54

Notes on the THAMES GOLD FIELDS. By S. Heydelbach Davis, F.C.S., F.G.S.
Tararu Creek 56
Tinker's Gully 56
Opitomoko Creek 60
Wiseman's Gully 61
Moanataiari Creek 62
Waiotahi Creek 63
Karaka Creek - 65
Hape Creek 66
Tararu Point 67
General Remarks 68
Memorandum of Instructions for G. H. Davis . . 69

Notes on the processes in use in the THAMES MINING DISTRICT, for the extraction of Gold from the Matrix. By W. Skey, Analyst
Loss in Milling 71
Mode of Sampling 71
Mode of determining the Yield . . . 72
Table of Results obtained by the Analysis for Gold of Tailings . 73
Results of Analysis of certain Gold Alloys referred to in Table 74
Results of Examination of certain samples of Pyrites for Gold . 74
Effect of the use of Sea Water . . . 75
Summary of Results 75
Causes of Loss 76
Remedies against Loss 79
Matrix of the Gold 84
Associated Minerals 85

On the Geology of the CAPE COLVILLE District. By Dr. Hector
COROMANDEL 88
Keevin's Point 90
Driving Creek 90
Tokatea Reef 92
Kennedy Bay 93
Wangapou Diggings 93
Tiki Reefs 94
Recapitulation of the Localities . . 95
Mercury Bay 97
TAPU CREEK 98
OHINEMURI 99
Whatakura Reefs 100
Waihi Reefs 101

On the Geology of CERTAIN DISTRICTS OF THE NELSON PROVINCE. By the late E. H. Davis, F.C.S., F.G.S., compiled from his notes.
Report on the Geology of the NELSON DISTRICT . 103
Introductory Sketch 103
Fundamental Rocks . . . 104
Copper 104
Chrome 106
Gold 106
General Topographical Features . . 107
River System of the District . . . 108
Superficial Deposits . . . 108
a. Alluvial Deposits 109
b. River Deposits . . . 109
c. Slope 109
Narrative of Explorations . . . 109
Geological Formations 110
d. Magnesian Rocks . . . 110
Olivine 110
Serpentine 111
Chromite 111
Copper 112
Iron 112
Earthy Minerals 112
Hydrated Rocks 112
a. Limestones and Calcareous Slates . . 112
b. Red and Green Maitai Slates interbedded with Sandstone . 113
c. Port Hills Series . . . 114
Intruded Plutonic Rocks . . . 115
Felstones 115
Syenite 115
Elvan Dykes 116
Brook Street Igneous Rocks . . . 116
Recapitulation 116
Relative Ages 117
Special Details 117
Detail Description of Section I. . . . 118
,, ,, ,, II. . . 119
,, ,, ,, III. . . . 120
,, ,, ,, IV. . . 122
Economic Value 122

DESCRIPTION OF SPECIMENS.
Dun Mountain 122
Windtrap Gully and Specimens . . . 124
Maitai River 124
Roding River 125
Roding River, and Aniseed Valley Specimens . 126

Serpentine River, a branch from Aniseed Valley . . 127
General Character of Roding River . . 128
Report on the Geology on the WANGAPEKA District . . 128
,, The Reefs . . . 129
,, ,, COLLINGWOOD District . . 131
Alluvial Workings . . . 133
Reefs 124

On the Geology of the MALVERN HILLS, Canterbury. By Julius Haast, Ph. D. F.R.S. 135
Carboniferous Series 136
Quartzose Porphyry Group . . . 136
Brown Coal Series 137
Selwyn Coal Series 139
Altered Coal Series 140
Kowhai Mine 142
Practical Suggestions 143
Quality of Coal 143
Quality available 144
Lines of Communication . . . 145

Report on the CALEDONIAN MINE, Thames Gold Fields. By Captain F. W. Hutton, F.G.S. .
General Description 146
Red Rock 146
The Reef 147
New Golden Crown Reef . . . 148
Associated Minerals . . . 148
Yield 149–50
Description of Plans . . . 149

Report on the Perseverance Company's Gold Mine, Collingwood. By Capt. F. W. Hutton, F.G.S. . . . 151

Report on the Collingwood Company's Coal Mine. By Capt. F. W. Hutton, F.G.S. 157

Notes on the Geology of the Hawke's Bay District. By Dr. Hector . 159

ILLUSTRATIONS.

PLATE.		PAGE.
1.	Map and Section—Middle Waipara . . .	18
2.	Sections—Mount Cook Ranges . . .	24
3–8.	Section—Amuri District, with Tabular Statement of Titles and Formations	46
9–11.	Sections—Malvern Hills . . .	54
12–14.	Sections—Thames Gold Field . . .	68
15–17.	Map and Section—Coromandel District . .	98
18.	Map and Section—Ohinemuri District . . .	102
19–20.	Map and Sections—Dun Mountain District . .	114
21–22.	Plan and Section—Caledonian Claim . . .	150
23.	Plan and Section—Perseverance Claim, Collingwood .	156
24.	Sections—Hawke's Bay District . . .	160

GEOLOGICAL REPORTS.

ON A COAL SEAM DISCOVERED ON THE MARAMARUA CREEK, WAIKATO. BY CAPTAIN F. W. HUTTON, F.G.S.

8th June, 1869.

COAL has recently been found in a new locality, between the Waikato and the Frith of the Thames. The position of the seam is between the Maramarua and Whangamarino Creeks (tributaries of the Waikato), and is distant, direct, about six miles from the Waikato, and ten from the Frith of the Thames.

The coal was found on land belonging to Mr. Foote; but I have not the slightest doubt extends beyond it into land belonging to the Government. The seam is not yet sufficiently opened up to say much about it, but it appears to be at least ten feet thick, and nearly horizontal. The coal is a hydrous coal, with retinite, apparently just similar to that already mined at Kupakupa, on the Waikato.

The Maramarua Creek is navigable for large boats or small steamers to within half a mile from the coal, and an almost straight road could be made with very little trouble, and only one small bridge, to the Frith of the Thames. This road would be almost level, only going over two rises, neither of them more than 200 feet above the sea.

The height of the coal above sea level I estimate at 200 feet. No pumping would be required for working it.

At a rough guess, I should say that the coal might cover an area of 400 acres. A correct survey of the block would take about three weeks or a month, as the country is very broken; and this survey it would be better to defer until the seam has been opened up, and its thickness and dip can be correctly ascertained. As Mr. Foote has put up a flax mill, and proposes to work the coal for the mill, a few months will probably see the seam well opened.

Immediately on my return I reported the circumstance to the Agent for the General Government, and pointed out the position of the coal to him; and the land has been withdrawn from sale.

ON THE GEOLOGY OF COROMANDEL. BY CAPTAIN F. W. HUTTON, F.G.S.

13th January, 1870.

THAT part of the Coromandel peninsula bounded by Tapu Creek on the south and Cabbage Bay and Kennedy Bay on the north (excluding its easterly extension towards Mercury Bay, which I have not visited), is similar in geological structure to the Shortland and Tararu Districts. By far the larger part, including the central dividing range, is composed of tertiary trachytic volcanic rocks, lying unconformably on a basement of older slates.

The upper surface of these older rocks is very uneven, being probably the tops of an old mountain chain, the valleys of which ran in different directions to those now in existence. A ridge of slates, some ten miles broad, appears to run in a N.N.E. and S.S.W. direction obliquely across the peninsula from Tapu and Waikowhau to the south side of Kennedy Bay, being exposed to view on both coasts, and here and there in the beds of the creeks that have cut down through the thick mass of superjacent volcanic tufa and breccia which forms the upper parts of all the mountains. With the exception of this band, I know of no other slate rocks in the peninsula south of Cabbage Bay and Wai-kawau Bay, for the small patch north of Tararu may be looked upon as a spur from this ridge.

A second ridge runs through Cape Colville and the central and northern parts of the Great Barrier Island in a north and south direction.

The mines of the Shortland, Tararu, and the greater part of the Tapu districts, are situated in the volcanic rocks lying on the eastern side of the first described band of slates; those of Coromandel are in the volcanic rocks on the western side; while a few at Tapu are situated in the slates themselves.

These slate rocks in the Coromandel District, as seen in the beds of the Matawai and Tiki Streams, are blue arenaceous slates, weathering into soft yellowish-brown slates. As already stated, their exposed area is very limited. They are of the same age as the slates at Tapu, already described in a former report. (Second Report on Thames Gold Fields.) The trachytic tufa, being the bed rock of the gold veins, and covering a large extent of country, is of far more importance than the slates; and in this district it is more diversified, and shows the transition from coarse soft agglomerate to hard fine-grained porphyry better than in any other part of the peninsula with which I am acquainted.

On first entering Coromandel Harbour I was struck with the general resemblance it bears to Port Fitzroy, in the Great Barrier Island. Both sides of the harbour are composed of volcanic agglomerate, consisting of pale-coloured trachytic tufa, containing blocks of variously coloured scoriæ and lavas, and occasionally traversed by veins of crystalline and drusy quartz. At the south head the agglomerate is covered by fine-grained tufa, distinctly stratified, and dipping about 20° N.E.

Higher up the harbour the agglomerate disappears, and at Keven's Point a finer grained although still rather coarse tufa takes its place. This tufa in general closely resembles much of what is found on the Great Barrier, but in places it could not be distinguished from specimens from the Waiotahi Creek at Grahamstown, and sometimes even it passes into a red porphyry.

A little north of Keven's Point, on the beach, about half-way between the point and the old wharf at Wynyardtown, a dyke some twenty feet broad is seen running in an east and west direction. This dyke is composed of dolerite, showing crystals of augite, and is similar to those found in the Freeman's Bay claim, Waiotahi Creek; the Cosmopolitan and Crescent claims, in the Moanataiari Creek; and in other places in the Thames Gold Fields. The tufa rock contains very little pyrites, but is traversed by many veins of crystalline quartz. Several years ago repeated trials were made of this quartz, but no gold could be obtained by crushing, although a specimen analyzed in the laboratory of the Geological Survey showed that it contained traces of the precious metal.

As we progress towards the ranges the rock gets harder, and in places much finer grained. At the Kapanga mine it consists of hard tufa and breccia of a light-gray colour, and highly charged with pyrites. This rock is exactly similar to the bed-rock of most of the mines at Shortland and Grahamstown. The top of the shaft of the Kapanga mine is about 330 feet above the level of the sea, and the shaft is about 300 feet,—as rich quartz being found at the bottom as at any other level. No variation of rock was encountered when sinking this shaft.

The whole of the bed of the Kapanga Creek is composed of the same volcanic rocks, which get coarser, and more like that at Keven's Point, towards the upper parts of the hills. On the very summit of the dividing range between Coromandel and Kennedy Bay, at an altitude of about 1,660 feet, a large reef, composed of white quartz, more or less crystalline, occurs, running in a north-west and south-east direction, and in places standing out like a wall to a height of twenty feet. It is probably some fifteen feet in thickness. Large blocks of quartz, either from this reef, or from one very like it, are found lying on the slopes of the hills below the Kapanga mine.

It was in feeders to this reef that gold was lately found by the prospectors of the district, who followed traces of the precious metal up the creeks that run into Kennedy Bay. The claim that they took up, known as McLeod's or the Tokatea claim, is situated on this reef, on the very top of the ridge. (Fig. 2.) A drive has been put in from the Kennedy Bay side of the range, and a small vein followed running at right angles into the main reef, and dipping 80° S.E. From this small vein most magnificent specimens of auriferous quartz have been taken. The drive has been extended as far as the main reef, which dips 60° S.W., but not through it. Fine gold has been found in washing the casing, but no crushing has been made as yet to test whether the main body contains any gold.

Below the Tokatea claim, on the north-east slope, rounded boulders of dolerite are found in the tufa.

The Harbour View, the Rakaia, the King of the Ranges, and many other claims, have found very rich stone; and when adequate crushing machinery has been erected, and wire-tramways constructed from the claims down to the machines, Coromandel will undoubtedly prove to be a most important mining district. At present there is only one four-stamper battery at work. It is driven by water power, and belongs to the Nil Desperandum claim.

It is well known that alluvial gold of a very superior quality to that obtained in the mines, varying from 21 to 22 carats fine, has been found in the creeks that run into Kennedy Bay, and in the Matawai, a branch of the Waiau. Before visiting Coromandel, I supposed that this gold was derived from the slate rocks, and was probably of a much older date than that found in the tufa; but on a closer inquiry, I ascertained that this explanation would not account for the facts, as I was informed that the richest finds of the best gold, including the largest nugget, were in a small branch of the creek running into Kennedy Bay, situated a little below the Harbour View claim, and above the junction of the tufa with the slates. Gold of very different qualities is found in the mines, but none so pure as that found in the creeks, so that at present the phenomenon appears inexplicable.

In my Second Report on the Thames Gold Fields, when speaking of the age of the volcanic rocks in which the gold mines of Shortland, &c., are situated, I said that "it is probable that this trachytic-tufa, breccia, and felspar-porphyry is of Upper Miocene age; but more information must be obtained before the question can be considered as settled." Having now examined the Coromandel District, I have no longer any hesitation in stating my conviction that the whole of the gold mines, with the exception of a few at Tapu, are situated in the lower submarine portion of that huge mass of volcanic ejections, extending in places over the whole of the northern half of the North Island, which began to be formed immediately after the deposition of the Waitemata series, and which is still being added to by the active crater of Tongariro.

The following metals have been added to the list given in my Second Report on the Thames Gold Fields as having been found in the district:—

Silver.—As red oxide in the Golden Crown mine.

Manganese.—As wad, in considerable quantities, associated with calcite in the Black Reef, Tararu.

Arsenic.—Native, in the Kapanga mine, at Coromandel.

ON THE GEOLOGY OF THE WAIPARA DISTRICT, CANTERBURY; WITH GEOLOGICAL MAP AND SECTIONS.

BY JULIUS HAAST, Ph.D., F.R.S.

25th November, 1869.

[An abstract of this Report was read before the Canterbury Institute (Proceedings of N.Z. Institute, vol. ii. p. 420); but, with Dr. Haast's consent, it has been reserved for publication at length with the Geological Survey Reports, as the first of a series on the same subject. Dr. Haast is at present engaged in examining the northern extension of this formation, so that the views expressed in this Report must only be considered provisional, and subject to revision as his researches are extended. I may state that my own opinion respecting the age of the Reptilian beds is still the same as that which I expressed in last year's Progress Report.—J. HECTOR.]

IN a paper read before the Philosophical Institute of Canterbury on the 2nd of June last, in which I gave a short description of the Saurian remains lately discovered in the River Waipara and its tributary, Booby's Creek, I stated that if we take only the palæontological evidence before us into consideration, namely, that finding the same genera of Saurians in New Zealand which occur in Europe only in secondary strata, and using European nomenclature, we must assign to them at least a Cretaceous age. (Trans. N.Z. Institute, vol. ii. p. 186.)

At the same time I referred to my sections, in which I classified the strata in which these Saurian remains occur as Lower Tertiary.

As the true position and age of these beds is of the highest importance in New Zealand Geology, I shall endeavour to state, in the following pages, the principal results of my researches into this portion of our New Zealand formations; but I do so with some diffidence, and wish to observe that a great deal more work has to be done before the age of our middle and younger sedimentary rocks can be finally settled.

Dr. Hector, in his Progress Report of 1868–69, p. xii, refers also to the same subject, and, classifying the Waipara beds according to palæontological evidence only—offered by the Saurian remains—he provisionally refers the strata in which they are found to an epoch corresponding with the Wealden group of Europe, whilst he considers the strata immediately underlying the so-called Weka Pass beds to be probably of the age of the greensand. I may here observe that the concretions with Saurian remains are *in situ;* consequently we cannot assume in any way that they have been washed from their original place of deposition to their present locality.

The examination of the Saurian remains staggered me considerably at first, and I considered that if the conclusions drawn therefrom were alone to be relied upon, we should be compelled to believe that the beds in which these Saurian remains occur must be at least of Cretaceous age,—of course always assuming that we can apply European geological nomenclature to New Zealand or to the Southern hemisphere in general.

However, I do not consider this palæontological evidence, principally if taken in connection with the other fossils found in the strata above and below them, to be at all conclusive, because the fauna and flora of Australia and New Zealand, both terrestrial and marine, present such a peculiar facies that they remind us, in many respects, of that of the fossil remains embedded in secondary and tertiary rocks in the mother country, and consequently exhibit, in many respects, a remarkable stationary character. The same striking feature might also have distinguished our organic world during those geological eras corresponding with the older tertiary epoch of Europe, when Saurians which existed in the seas of both hemispheres during the secondary age, might have outlived the time of their extinction in the Northern hemisphere, and still continued to flourish in the older tertiary seas of New Zealand.

I am led to make this observation, which may sound exceedingly heterodox, because I have been informed that in the Amuri District similar bones have been discovered, together with true jurassic fossils, and also in Australia, together with ammonites and belemnites.

As these Waipara beds are of such great interest, I shall offer you in the following pages a description of them, from which it will be seen that they are not only identical with the brown-coal bed series all along the eastern base of the higher mountain ranges in this Province, but also that they can in no way be separated from those beds in Auckland, Nelson, and elsewhere, which have been described by Professor Von Hochstetter and others as being of tertiary age.

I must, however, state that I have not been able to obtain as yet any distinct remains of the fossil flora in the shales and lignites of the Waipara beds; but as in that locality they are overlaid by the same *Ostrea* beds, with some other shells—of which I shall offer a description in the sequel, and which occur in the Malvern Hills, the Waimakariri Basin, and other localities exactly in the same position—we may safely conclude that the Waipara lignite beds are of exactly the same age as those in the localities just mentioned. In the shales belonging to the lignite and brown-coal beds of this same series, I have found plants identical with those collected by Hochstetter in the brown-coal beds of Auckland and Nelson, and described by Unger.

A leaf called *Fagus Ninnisiana* by that distinguished botanist, and which forms the greatest portion of the fossil plants in the Northern fields, is also most frequently met with in our Province. In fact, as far as my experience goes, there is not a single form in our shales which has not been found in Nelson or Auckland. Again, if we compare the flora of the Grey River coal-measures and of the Pakawau beds—of which we possess a large collection in the Museum—with the flora from the brown-coal beds, we shall find that there is not a single species identical between them, although both consist mostly of dicotyledonous leaves, with the exception of a few species of palms, ferns, and zamites. Moreover, the Putataka or belemnite beds, near the mouth of the Waikato, in Auckland—called by Dr. Hochstetter and Captain Hutton, secondary, and by Dr. Hector, cretaceo-tertiary—contain species of ferns,* none of which, as far as I am aware, have ever been discovered in the brown-coal series or the Grey coal-measures.

Whatever may be the age of these brown-coal or lignite beds in the Waipara, one thing seems clear from the evidence before us, that they are of the same age as the brown-coal beds of Auckland and Nelson, and younger than the Grey River coal-measures and the Putataka or belemnite beds of Auckland.

The Malvern Hill beds, the similarity and co-relative age of which with the Waipara beds I shall be able to show from their fossil contents, repose in many localities, instead of on palæozoic stratified rocks, on trachytic tufas and breccias, which, in several instances, are also associated with the brown-coal beds themselves, by being interstratified with them. This fact is of such great importance that it ought not to be overlooked when speaking of the age of the Waipara beds, and which struck me at once, as I pointed out in my paper on the palæontological evidence of their age, read on the 2nd of June. I stated there that if these Saurian remains are at least of Cretaceous age, the trachytic rocks of the Malvern Hills, Mount Somers, &c.,

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* The characteristic fossil fern of this formation, *Polypodium* (*Pecopteris ?*), *Hochstetteri*, was obtained many years ago by Mr. Lyon, F.G.S., and again in October last by myself, with the lower coal beds in the Malvern Hills. It also occurs at Pakawau, so that the above inferences require more direct evidence. In Mr. Holmes' collection from Waipara, the only distinct plant-impression contained in the low bed appears to be a *Damara*.—J. HECTOR.

must be called quartzose porphyries. Such a nomenclature would, however, be totally incorrect, as these Malvern Hills and Mount Somers rocks are real quartzose trachytes, and consequently volcanic rocks, resembling, in many respects, those of Transylvania and Rhenish Prussia.

Now it has been clearly shown that the oldest volcanic rocks of Transylvania only made their appearance towards the end of the Eocene, and those of the Rhine during the Lower Miocene epoch.

If at the same time we consider that, besides the resemblance of the volcanic rocks of both localities, and principally between those of the Rhine, where there is also a great similarity in their association with the brown-coal beds, the latter are disturbed and overlaid in both hemispheres by basic volcanic rocks, and that nowhere volcanic rocks of secondary age of such character as our Malvern Hills and Mount Somers series exist, we must come to the conclusion, taking all these facts into due consideration, that we cannot assign a secondary age to the beds under review. It would really be a most peculiar circumstance that whilst, all over the known world, true volcanic rocks, both acid and basic, are tertiary, we should find them in New Zealand of secondary age.

In the strata both immediately above and below the Saurian beds of the Waipara and Booby's Creek no fossils have ever been found, either by myself or any other collector, which have a cretaceous facies, although some of these strata would, from their nature, be well fitted to preserve remains of cephalopods, such as belemnites and ammonites, had they ever existed at the time these beds were deposited.

Before giving an enumeration of the different strata in the Waipara, I may state that the beds Nos. 1 to 10 seem to me to follow each other conformably, and in an unbroken sequence,—that they are the deposits in a bay the level of which oscillated sometimes, the downward movement being, however, the most predominant.

I do not mean to say that all the beds strike and dip exactly alike, because it cannot be denied that, according to the form and slope of the sea bottom, the presence or absence of sea currents, or the entrance of fresh-water courses into the sea, the formation of the beds must have greatly varied. Sometimes they must have been interrupted in the process of deposition, or sometimes a partial destruction of the beds already formed must have taken place. But I do contend that the beds have been deposited, geologically speaking, without any breaks except those mentioned above,—that they belong to the same series, and mark clearly a well-defined period in the past history of this portion of the globe.

In examining into the former condition of the country, before the strata were thrown down, we find that a large bay existed, formed by the Doctor's Range, running E.N.E. and W.S.W., and its continuation on the southern side of the Waipara Gorge, and by the Mount Grey Range, running W.N.W. and E.S.E.

Along the shores and round the small islands in this bay the lower strata were first deposited in shallow water. In this way many hollows and irregularities of the ground were filled up, which afterwards allowed the younger series of these beds to stretch along uninterruptedly from side to side, and run nearly parallel with the direction of the Doctor's Range.

The geological map (scale, 1 mile to 1 inch), and the ten sections* drawn on a larger scale, will acquaint the reader more fully with the characteristic features of the district under review.

I may say, in explanation, that I have, in order to ensure more clearness, omitted to show in the geological map the alluvial deposits of Post-pliocene age occurring in the Middle Waipara District, which, however, I have shown in the sections.

I shall now proceed to give a description of the different beds occurring in that region, and into which section No. 1, from the Doctor's Range across the Deans to the Waipara River, gives the best insight, as they seem there to follow each other conformably—which, however, is only apparent, as I shall show in the sequel, for the upper portion from No. 11 upwards.

The Doctor's Range is formed of fine-grained or coarse micaceous sandstone, clay slates, indurated shales, and all the great variety of sedimentary rocks of younger Palæozoic (or secondary) age, which form the higher front ranges bounding the Canterbury Plains. The strata dip mostly at very high angles, and change their strike and dip greatly at very short distances.

Where the Waipara leaves its rocky gorge, and enters into the younger Estuary series, the mass of the rocks consists of fine-grained sandstones, with smaller bands of indurated shales, which strike W.N.W. to E.S.E., dip N.N.E. 68°.

Some distance from the younger Estuary deposits,—probably from the effect of former weathering and exposure to the action of sea water for a long period,—the Palæozoic rocks have changed their structure, and exhibit the nature of a true greywacke.

On this rock repose unconformably (No. 1) rusty-coloured loose sands, with some harder bands of limonite sandstone about 30 to 60 feet thick, and strike nearly N. and S., dip towards E. 33°. (All the bearings are magnetic.) These beds form almost everywhere the bottom beds of the Estuary deposits. They are succeeded in ascending order by (No. 2) white quartz sands, mostly angular. Between them occur

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* Section No. 2 only has been lithographed with the map, as it sufficiently represents all the details given in this Report.—J. HECTOR.

(No. 2B.) several seams of lignite and shales,—the former of very inferior quality, and from 9 inches to 2½ feet thick, 275°; dip E. 32°.

I did not obtain any distinct impressions of plants in them; but in beds occupying exactly the same position in the Malvern Hills (Jebson's coal mine), in Raincliff Gully, and in the Motenau River, I collected impressions of dicotyledonous leaves of the following species:—*Fagus Ninnisiana*, *Phyllites eucalyptroidus*, *Loranthophyllum dubium*, *L. Griselinia myrtifolium*, *&c.*, and described by Unger, from specimens collected by Hochstetter in Auckland and Nelson, and considered by both as indicating a true tertiary age.

(No. 3.) Angular loose quartzose sands, covered frequently with an efflorescence of sulphur, and not showing any stratification.

I may here observe that the brown-coal beds of New Zealand present in many respects a close resemblance to those of Germany of Miocene-tertiary age, both in lithological character as well as in the sequence of their deposition, and in the occurrence of basic-volcanic rocks, which have acted an important part amongst them.

(No. 3B.) They are succeeded by an Ostrea bed of an average thickness of 6 feet, having the same strike as No. 2, but dipping only at an angle of 29°. It consists here mostly of fragments of a large Ostrea, which is, however, occasionally embedded in a perfect state amongst the small pieces.

This Ostrea, which is still undescribed, has very thick shells, is of a dark-bluish colour, and is 5 to 6 inches long, and 4 to 5 inches broad. Associated with it we find *Conchothyra parasitica* (McCoy), a small Cardita, and some other shells in such a fragmentary state that I was unable to recognize them. In the same beds in the Malvern Hills, which are, however, of much larger dimension, I found, besides this large Ostrea and *Conchothyra parasitica*, a large Panopœa, a Buccinum, a large Natica, and some casts of bivalves, which I have not yet had an opportunity of examining more fully.

There are some more localities in this Province which I have examined, containing in the same bed a great many more fossils, and which will doubtless throw still more light upon their age in correlation to other New Zealand strata. However, I may here observe that hitherto I have never found any fossils, either complete or fragmentary, such as ammonites or belemnites, or other characteristic cretaceous or jurassic forms, which would induce me to conclude from their existence that we have to do with older than tertiary strata; and as I have searched in vain over hundreds of miles, I have now given up every hope of ever finding such truly secondary fossils in the strata under review.

This bed (No. 3B.) is therefore of great importance, as it offers conclusive evidence that the Malvern Hills strata, with brown-coal beds and quartz sands, are of the same age as those of the Waipara.

No. 3c. Immediately above the Ostrea beds repose about ten feet of sandy clay iron ore, which is succeeded by (No. 4) sharp loose quartz sands, sometimes full of glauconite, and covered in places with an efflorescence of sulphur. These beds are often mottled and streaked dark green or rusty yellow. They are about 70 to 150 feet thick, and contain no fossils in the Waipara. In the Waimakariri basin, however, of exactly the same nature and age, they are full of the same large Ostrea imbedded throughout.

No. 4a. Gradually these sands become less ferruginous and more argillaceous, having a thickness of about 200 feet. It is this stratum in which the concretionary nodules of limestone are embedded, forming regular lines of stratification, and lying about ten to twenty feet from each other.

These nodules have a bluish colour in the Waipara, and are of a hard semi-crystalline texture; in Booby's Creek they are of a somewhat softer nature, being at the same time glauconitic, and of a greenish or yellowish colour.

In both localities remains of Saurians and of plants are imbedded in them. I opened many of these concretions, both large and small, and observed that in the very large ones often only small remains of bones were enclosed, whilst sometimes smaller ones contained bones of larger size.

The organic remains are not always in or near the centre of the concretions, but very often towards one or other side, or even close to the surface—an observation also made by Mr. Robert L. Holmes while collecting fossils from them for the Colonial Museum.*

No distinct beds of this rock are found in the River Waipara, although they occur in Booby's Creek. I met with similar beds also on the banks of the southern main branch of the Waipara, forming Burnt-hut Hill, which ought to be carefully searched for fossils.

The observation may not be without interest, that I have found nowhere south of the Waipara similar concretionary nodules, which also occur frequently in the northern portion of this Province, as for instance, in the Upper Waipara and in some of the tributaries of the River Hurunui, yielding Saurian remains of the same character.

No. 5. These Saurian beds are overlaid by calcareous greensands of an average thickness of 80 to 120 feet, and full of glauconite. I found in these greensands *Waldheimia lenticularis*, of common occurrence in the Weka Pass beds (No. 10), and some pieces of a Pecten, too small for recognition. From a similar bed in the same horizon, near the sources of the Apuha, I obtained a large Inoceramus, closely resembling the *Inoceramus planus* of Europe.

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* Mr. Holmes still adheres to his opinion that the concretions containing the bones have been deposited in the sand bed as rolled masses, as Dr. Haast offers no explanation of how the fragments of bone are exposed as waterworn surfaces on the exterior of the boulders.

The Inocerami being of jurassic or cretaceous age in Europe, becoming extinct before the tertiary period, we have here at least one instance of one form of a lamellibranchiate mollusk occurring in these beds, which is characteristic of a truly secondary age.

In continuing our survey of these beds, we reach next in ascending order No. 6, micaceous bluish clay marls, of a thickness of about 50 to 70 feet, which are again overlaid by (No. 7) greensands, arenaceous, thickness about 80 to 100 feet. They have a bright green colour, and consist of harder bands, of a thickness of 2 to 4 feet, forming protuberances, alternating with more incoherent beds of the same character, and 5 to 6 feet thick. In some localities more towards the limestone gorge of the Waipara, these beds are blackish green, and consist almost entirely of grains of glauconite. They strike 291° N.N.E. to S.S.W., with a dip of 19° towards E.S.E.

No. 8. They are succeeded by argillaceous beds, sometimes finely stratified, and covered in many localities with an efflorescence of sulphur. They still contain a small quantity of glauconite grains, exhibit sometimes a false bedding, and are about 60 to 100 feet thick.

No. 9. They change into grey clay marls, breaking, on exposure, into small fragments. These beds are from 60 to 100 feet thick.

In the beds Nos. 6, 7, 8, and 9, fossils are of rare occurrence, and I discovered none different from those imbedded in No. 10, of which the most important ones are two small pectens, *Waldheimia lenticularis* and *Scalaria (Brownii?)*.

If these beds, which I searched carefully, were in any way the correlates of the belemnite and ammonite beds of the Northern Island, there is not the least doubt that, owing to their great extent, both vertically and horizontally, they would have yielded some of these characteristic fossils in this Province; and although we possess only negative evidence on this point, I consider it so strong that I have not the least doubt that these beds must be younger than the Northern Island strata in question.

No. 10. We now reach one of the most characteristic and principal beds in the whole series, abounding in fossils, and having, from north to south, almost invariably the same facies, graduating from a calcareous sandstone into a tufaceous limestone, sometimes resembling a chalk marl or even a chalk.*

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* This is the Ototara limestone of Mantell, which was considered by Professor E. Forbes and R. Jones to present mixed characters of the eocene and upper cretaceous formations. (Quar. Jour. Geol. Soc. vi. 329.)

I have called these strata sometimes the Weka Pass beds because they yield in that locality a very good building stone, well known to the inhabitants of the Province. In the Museum, however, I have ticketed these fossils as coming from the Curiosity Shop beds, because it was in that locality, on the banks of the Rakaia, that the greater part of the fossils under review have been collected.

It would be tedious to offer you here a list of all the fossils found in them, and I shall therefore confine myself to enumerating only the principal leading fossils which have been collected in both Islands, in beds of correlative age, generally from one end of New Zealand to the other:—

Brissus eximius, Zittel.
Brissus Crawffordi, Hector.
Hemipatagus formosa, Zittel.
Schizaster sp.
Pecten Hochstetteri, Zittel.
Pecten Hutchinsoni, Hector.
Pecten Fischeri, Zittel.
Waldheimia lenticularis, Deshages.
Waldheimia Gravida.
Scalaria lyrata, Zittel.
Scalaria Brownii, Zittel.
Scalaria species, undescribed.
Teeth of Carcharodon.
Teeth of Lamna.

These beds are about 80 to 100 feet thick. On the crown of the so-called Ram Paddock they strike from S.S.W. to N.N.E., with a dip of 20° to the E.S.E., and form some of the most picturesque features in our lower mountain regions,—forming castellated rocks, and other wild and fantastic scenery.

No. 11. These Weka Pass beds, which terminate the Lower Tertiary series, are overlaid conformably under the Deans and at the limestone gorge of the Waipara by grayish or greenish calcareous sands, sometimes containing small beds of clay marls, the stratification only shown by beds of a harder nature occurring occasionally amongst them, and consisting of a coarse sandstone, which is formed of the same material, but cemented together by a calcareous matrix.

These beds, sometimes several hundred feet thick, rarely contain any fossils; but when they occur, they show their similarity with those found in the Pareora or Cucullæa beds. I obtained from them, besides *Waldheimia lenticularis*, a Scalaria allied to *S. lyrata*, and a small Turritella, so common in the Cucullæa strata in other portions of the Province. Considering that these Cucullæa beds are generally teeming with the remains of animal life, the scarcity of fossils in these beds is very striking. In other localities the following genera are well represented, mostly in several species:—*Cucullæa*, *Turritella*, *Fusus*, *Voluta*, *Triton*, *Ancillaria*, *Struthiolaria*, *Pectunculus*, *Purpura*, *Dosinia*, *Ostrea*, &c.

I consider that these beds are of the same age as the Awatere beds in the Province of Marlborough, from which many identical forms collected by me have been described by Zittel and Hochstetter, occurring there also in great variety.

No. 12. We have now arrived at the strata which act a prominent part in the orographical features of the front ranges, and which form the highest peaks of our tertiary hills, such as the Deans, Mount McDonald, Mount Vulcan, the hardness of the rocks of which the upper portion consists having better resisted the influence of atmospheric action than any other tertiary rock in the whole series. In fact many of the beds below them would have been destroyed long ago had not these overlying strata protected them so effectually.

The lowest beds consist of dark-bluish sands, generally calcareous, in which a small *Waldheimia* and a blackish finely-ribbed *Pecten* are of common occurrence. In them small beds of rusty-coloured tufaceous or brecciated limestone occur, which, as we ascend in the series, become more and more frequent, and of broader dimensions, till we reach the uppermost bed 30 to 40 feet thick, by which the summit of the Deans and Mount Brown and their eastern slopes have been formed.

Some of these harder beds consist almost entirely of fragments of shells; others of corals, being, in fact, a true coral rag; others contain innumerable and remarkable cup-shaped *Bryozoa;* others are formed of Ostreas. Some species of *Waldheimia* and *Pecten* are also of frequent occurrence.

The principal *Ostrea* is of small size, and of a white nacreous appearance. This coral rag has in many localities not only the same strike and dip as the beds upon which it reposes, but also as the still lower ones, such as the Weka Pass beds. However, I shall show in the sequel that even the lowest beds of the series repose unconformably in some instances upon the uppermost beds of No. 11, or those lying immediately below them.

The occurrence of these beds, which show us clearly that they have been deposited in shallow water, prove convincingly that the land had been rising since the deposition of the Weka Pass beds (No. 10), which must be of a deep-water formation, the land having generally been sinking from the beginning of the brown-coal formation.

For some time I was under the impression that the beds Nos. 11 and 12 were simply the upper series of the Weka Pass beds, although in a few instances I had observed unconformity between them; but on further examination I found, as first suggested to me by Dr. Hector, that such connection cannot be traced; in fact they constitute a distinct series by themselves.

When treating of the stratigraphical relations of the whole, I shall once more return to the subject; but I may here add, before leaving it, that they may be considered to form the middle series of our tertiary formations.

The strata reposing upon them strike also in the same direction, and have generally the same dip, but they form only low hills in front of the older tertiary rocks, rising seldom 600 feet above the sea level. I have called these strata "younger tertiary" in my maps and sections.

No. 13. The strata which immediately repose upon the Mount Brown series consist mostly of arenaceous and argillaceous beds, clays, sometimes marly or loose marine sands. The clays enclose often concretions of sandy limestones, and also harder beds of the same rock, impregnated with lime, and alternating many times with each other.

In them we meet, and often in a perfect state of preservation, with a great variety of fossils, such as *Cardita*, *Lutraria*, *Buccinum*, *Cerithium*, three species of *Ostrea*, *Struthiolaria*, *Trochus*, *Strombus* *Voluta*, *Trochita*, &c. These beds are either of littoral origin or shallow water deposits. They are much more strongly developed in the northern part of the Province, and, amongst other localities, form at the Motunau River beds many hundred feet thick, with a great variety of shells, and enclosing also Cetacean remains.

No. 14. They are overlaid by beds of conglomerate, mostly formed of small river shingle, and consisting of the *débris* of the palæozoic ranges near the upper course of the Waipara; but the destruction of some of the older tertiary rocks has also furnished material for their formation. These beds are together of a thickness of about 300 feet. Some contain two species of oysters, which sometimes form regular beds. There occur, also, some casts of Gastropods, mostly filled in the interior with crystals of calcareous spar.

No. 15. They are capped by loose marine sands, sometimes very calcareous, full of fragments of shells, and of a light-yellowish or greenish colour. Here and there harder bands of calcareous sandstones stand out from them as protuberances.

The same *Ostrea* and a large species of *Pectunculus* and *Pecten* occur in them. Between them occur beds of conglomerate like No. 14, the interstices between the pebbles mostly filled up with calcareous spar.

These newer series of tertiary beds (Nos. 13 to 15), which are overlaid unconformably by Post-pliocene river shingle, crop up again on the other side of the Waipara Plains, and dip in the opposite direction, thus forming a synclinal.

The enumeration of these strata will make it evident that they must be of a thickness of several thousand feet, for the formation of which a long space of time has been necessary; showing, also, a great depression of the area under consideration, principally during the end of the Lower Tertiary period, when deep-water beds were deposited, such as are now in course of formation, according to the late researches of Dr. Carpenter and Professor Wyville Thomson, in the Atlantic Ocean in 600 to 800 fathoms of water.

I have previously stated my views on the character of the sea-bottom upon which the older tertiary strata were formed; and I wish here to add, that although the brown-coal beds were deposited around the islands in the bay and around the base of the ranges, the same process did not take place with the beds overlying them, which were deposited in a general direction from W.S.W. to E.N.E., running in nearly parallel lines, starting from the flanks of Mount Grey, almost at right angles to the direction of that chain.

After the deposition and consolidation of the Weka Pass beds, the whole series seems to have risen to such an extent as to come under the full destructive action of tides and currents, if not even under subaërial influence. In consequence, denudation, in some instances on an enormous scale, has taken place, which affected partly the area both north and south of the lines of islands, but principally the upper beds of that series, which had been deposited in a northern direction from the locality where now Mount Brown is situated.

The magnificent sections which are here exposed in and near the banks of the Waipara, give us a clear insight into the extent to which the denudation has taken place.

The Weka Pass strata, which, for about 2½ miles, had formed a continuous line along the western slopes of Mount Brown, cropping out all along at nearly an equal altitude, and still form a considerable bluff on the southern bank of the Waipara, suddenly disappear on the northern bank, and only younger strata, reposing unconformably against them, as seen in the river bed, replace them.

This great denudation was caused, without doubt, by the long continued exposure of the older rocks to tides and currents which, most probably, swept here round from the north.

That the denudation of the Weka Pass beds had taken place previously to the deposition of the Cucullæa beds No. 11 is well shown in the sections Nos. 6 and 7, where the Weka Pass beds stand as isolated islands between the latter, abutting unconformably against them.

However, the newer strata No. 11 must in some instances have been deposited very soon, as the uppermost beds of the Weka Pass series have not only been preserved entirely, so that no sign of denudation is visible, but the Cucullæa beds overlie them in most instances so conformably that it is impossible to detect the least difference in strike and dip, as, for instance, near the limestone gorge of the Waipara.

Likewise it may be stated that the coral rags No. 12 lie generally in a conformable position to the former. However, an examination of the sections Nos. 2, 7, 8, and 9 will offer convincing proof that this is not always the case, but that in those instances the Cucullæa beds were subjected to remarkable denudation before the coral rags were deposited, which, as it seems, covered all the strata as with a mantle wherever a favourable opportunity occurred, and of which the northern slopes of Mount Brown are a remarkable instance; and although some of these beds are so situated that faults or similar disturbances suggest themselves at once to us to have caused their peculiar position in the banks of the Waipara and on the slopes of Mount Brown or the Deans, a closer examination will prove that they were deposited in a regular manner.

The occurrence of the Weka Pass beds falling here abruptly towards the north has caused the formation of a submarine valley, which the beds No. 11 were unable to obliterate. Moreover, the latter, after being again partly denudated, were covered by coral rags, which, sloping gently down from the Deans, when in contact with the Weka Pass beds alluded to, rose quite abruptly, thus forming a synclinal. It is through this synclinal that the Waipara has forced its course, breaking first through the Weka Pass beds in the beautiful limestone gorge, and cutting afterwards through the Cucullæa series.

The section No. 5 has been prepared in order to show the nature and extent of the older strata round the palæozoic islands, and the junction of the younger with the older series.

The Bryozoa beds near the Natural Bridge Creek, belonging to the coral rags, cease shortly when ascending Booby's Creek, and the strata No. 11 form again both sides of the rocky gorge of that small Waipara tributary, their dip gradually rising until half-way between the junction of the Natural Bridge Creek and Booby's Hut they dip at an angle of 75°, which afterwards diminishes again to 46°. These beds overlie unconformably micaceous sandy clays, sometimes with incrustations of sulphur. They doubtless represent No. 6 of the main river, and are underlaid by argillaceous glauconite sands, appearing sometimes almost black when wet.

In following them towards their middle portion, they assume more and more the character of greensands, and become finally, towards their base, of a rusty tint. They are several hundred feet thick, and are, without doubt, the correlates of No. 5 of the main section. They are underlaid by gray or yellowish sand, sometimes very ferruginous, in which the large concretions containing Saurian and other organic remains are imbedded. (No. 4a. of section No. 1.)

These concretions are here apparently not imbedded so regularly as those in the main river, and the whole is underlaid by a bed of hard concretionary bluish limestone, similar to the Saurian concretions, of a thickness of a few feet, and dipping, at the place of observation, at an angle of 13° to the S.S.E. No more concretions occur below this bed.

Still descending, we find below them glauconitic sands, often stained and mottled, light-brown and rusty coloured, probably from the effect of the partial decomposition of the grains of glauconite. Here and there occur small layers of sandstone. (No. 4 of main river section.) The lower portion of these sands assumes a white colour, and reposes upon thin beds of shale or impure lignite, dipping at an angle of 15° to E. by S. These latter are again underlaid by the sands of which the Ostrea beds (No. 3B.) form an important member.

The Ostrea beds are, in this locality, not of great horizontal extent, because they occur only in a few branches of Booby's Creek and are missing in others, where their position is taken by calcareous sands.

In several localities, such as the Booby's Creek waterfall, this bed consists mostly of complete specimens of the large Ostrea; in others the enclosed fossils are of a more fragmentary character. They contain, also, the smaller species of mollusca previously alluded to.

Below them, angular white quartzose sands, similar to No. 3 in the main river sections, occur, under which several seams of lignite and shale are exposed, altogether about 10 feet in thickness. Some of the seams contain lignite of better quality than that observed in the main river. They dip N.E. at an angle of 11°, and are underlaid by rusty-coloured loose sands, similar to those found in the Waipara, and which also here form the base of the whole series.

Below them bluish or greenish palæozoic sandstones with indurated shales crop out, the first portion of them much weathered and dipping S. by W. 71°. They extend a few hundred yards along the bank of the rivulet which runs through them in a deep rocky gorge, and afterwards emerge into a broader bed, where the brown-coal series again make their appearance. They follow all the outlines of the underlying palæozoic rocks, which, after that distance, crop up for the second time, forming a more considerable portion of the island in the former tertiary sea.

Between the largest island and the northern spurs of Mount Grey the older tertiary or brown-coal series fill up the former channel of the sea. The whole is very often capped by Post-pliocene alluvial deposits, which were formed before the present deep gorges had been cut by the watercourses through the tertiary and older strata.

To sum up the results of my researches, we have to conclude that the beds in which the concretionary nodules containing Saurian

remains are imbedded, when compared with European geological divisions and from a similar palæontological point of view, ought to be considered of at least Cretaceous age.

But if, on the other hand, we examine the beds above and below them, we observe that they are often deposited upon trachytes, and broken through and disturbed by dolerites and nephelin rocks, true volcanic productions, to which we cannot assign a greater age than the beginning or even the middle of the Tertiary epoch.

The brown-coal beds, also, occurring below them, correlate with the brown-coal beds in the Northern Island, which overlie unconformably Captain Hutton's Putataka beds with true cretaceous fossils; consequently the whole series of the Waipara River, from the absence of secondary and the occurrence of tertiary fossils, must be considered younger than the belemnite beds of the Northern Island.

They also appear, if we compare their flora with that of the Grey River and Pakawau coal-measures, younger than these latter beds.

It remains, therefore, to be proved that either the belemnite and ammonite beds lie above the brown-coal series, or that characteristic cretaceous or jurassic fossils occur above them; I mean here, brown-coal beds, with *Fagus Ninnisiana* and the large Ostrea beds immediately above them.

If, therefore, the Saurian beds, lying often several hundred feet above those brown-coal beds of the Waipara, are of secondary age, all our so-called Lower Tertiary strata must be classified as secondary; but it would be impossible to reconcile such a classification with the results of our past and present experience.

NOTES ON THE GEOLOGY OF THE CENTRAL PORTION OF THE SOUTHERN ALPS, INCLUDING MOUNT COOK.

BY JULIUS HAAST, Ph.D., F.R.S.

3rd April, 1870.

AFTER an interval of seven years, I again visited, during the autumn of last year, the Mount Cook region, for the purpose of obtaining some additional geological information, and to collect specimens in all branches of Natural History for the Canterbury Museum, as well as a set of geological specimens for the Colonial Museum.

During my first journey, in the year 1862, I ascended the Mount Cook Range to an altitude of about 7,600 feet. In 1865 I examined, amongst other localities, the western slopes of the Southern Alps near and along the Francis Joseph Glacier, five miles north of the highest summit of Mount Cook. In 1868 I went again to that portion of the West Coast, and examined part of the western slopes of the Moorhouse Range. Mount Cook being situated in a more easterly direction than the Moorhouse Range and Mount Stokes, to which latter it is united by a low *nevé* saddle on its western flanks, it was my intention to ascend the Moorhouse Range as far as I could, in order to get more geological data of that westerly portion of the Southern Alps, which, west of Mount Cook proper, is only accessible from the West Coast.

Owing to the steepness of the eastern side of the Moorhouse Range, and the crevassed nature of its glaciers, I was only able to ascend to an altitude of about 6,500 feet, collecting, however, data enough for an elucidation of the geological structure of this gigantic range. I may here observe that the numerous glaciers which descend in every direction from the summits of this and all the neighbouring mountains, afford additional information as to the nature of the rocks of which these peaks are composed. I was thus enabled to judge, from the moraines of the Mueller Glacier and its tributaries, of the rocks of which the highest summits of the Moorhouse Range are formed; from the moraine lines on the Tasman Glacier, near the junction of the Hochstetter Glacier, of the rocks which compose the very summits of Mount Cook and Mount Tasman; and on the Francis Joseph Glacier, of those of which Mount Haidinger is formed.

In former publications I have pointed out what the general structure of the Southern Alps in this Province is, namely, that it consists of a succession of folds of sedimentary rocks of older Mesozoic, or younger Palæozoic age, an endless succession of sandstones and shales, slates, conglomerates, and brecciated (greywacke) rocks.* A remarkable feature in these ranges, of such large extent, deserves notice,—which is, that limestones are altogether missing. There are, however, a few localities where the slates have a slight admixture of lime, and others where the sandstones have a slightly calcareous matrix. Fossils are also exceedingly rare, and, except in a few spots where fossil plants of Jurassic or Carboniferous age (the question is as yet far from being settled) occur, there is, as far as I know, only one locality where fossils giving evidence of abundant marine life are met with. This locality is on the left bank of the Clyde, one of the source branches of the Rangitata, where I collected a great quantity of fossils, mostly Brachiopods, which, according to Professor McCoy, of Melbourne, who examined them, are of Lower Carboniferous, or Upper Devonian age.

During my last journey, although I devoted a great deal of time to searching, I met with no fossiliferous beds, if we except a few blocks of clay-slate in the moraine of the Hochstetter Glacier, exhibiting casts of tracks of Annelides. There are, however, in two places distant from each other indurated shales which contain obscure plant impressions resembling fucoid shales of Europe, namely, in the banks of the Happy Valley Creek, eastern side of the Four Peak Range, and on the southern flanks of Mount Cook. There are also in the same regions no signs of plutonic, eruptive, or volcanic rocks.

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* The synclinals forming generally the summits of the ranges, and the anticlinal the valleys.

Although the rocks are mostly everywhere of the same character, there are a few zones where they are somewhat altered, as if abysso-dynamic causes, which do not appear on the surface, had acted upon the rocks exposed, the sandstones assuming a chertose character and the slates being more arenaceous than they usually are. In other localities the sandstone formation seems to overlie unconformably older rocks of a somewhat metamorphic character, and of which the altered brecciated sandy slates on and near Burke's Pass, and the foliated argillaceous and quartzose schists in the Sealey Peak, and Mount Ward in the Hopkins, are instances. Hitherto I have, however, been unable to trace the lines of contact, as they generally follow the valleys and depressions, or are concealed under alluvial or morainic beds.

It will, however, be scarcely necessary for me to add that these sections are only offered as a slight contribution to the geology of the Southern Alps, and that a great deal of time has to be devoted before the structure of these stupendous chains can be quite explained. Leaving the description of the eastern coast ranges for a future occasion, I shall begin with the ranges immediately east and west of Burke's Pass. Here, on the eastern side of the Opihi, in ranges which rise about 3,500 to 4,000 feet above the level of the sea, we find great masses of brecciated sandy slates and sandstones, sometimes alternating with dark bluish silky clay-slates. Some of the beds are occasionally impregnated with iron pyrites, and contain small veins of ferruginous quartz. It was in this creek that, in 1862, I picked up a specimen of quartz with a speck of gold in it. In some portions of the ranges the sandstones, in others the slates, predominate; the sandstones, having from their hardness better resisted the action of the atmosphere, stand out as protuberances on the summits and sides of the mountains. The general direction of the strata is north and south, with a dip to the east varying from north-east to south-east, often at very short distances.* The accompanying section, No. 1, will give some of the details. Having crossed Burke's Pass, the brecciated and sub-foliated slates, &c., cease, and blue and grey clay-slates (roofing slates), bluish and greenish sandstones of a sub-crystalline texture, take their place. The strike of the beds is nearly the same as on the Pass, but now dipping in an opposite direction, namely, towards west.

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* All bearings are magnetic.

Near Lake Tekapo the beds are still less altered, sedimentary rocks, indurated sandstones, with shales and clay-slates, alternating. As before observed, hitherto I have been unable to trace clearly the junction of these and the former beds. The morainic accumulations a few miles above the southern end of Lake Tekapo still rise to an altitude of about 1,000 feet above its present level, whilst everywhere in localities favourable for their preservation, lacustrine beds (glacial mud) have been deposited between and along the moraines, rising to about 100 feet above the lake, thus showing that since the retreat of the post-pliocene glacier, the lake then filling the bed of the former has lowered its level considerably.

The ranges between Lake Tekapo and the Irishman Creek consist of grayish and greenish indurated sandstones, conglomeratic beds, and dark clay-slates and shales; in some localities arenaceous, in others argillaceous beds, predominate. However, the changes are often so rapid that in one locality (in the banks of the neighbouring Cass River) I counted, within a distance of 300 yards, over 600 changes, the whole having a ribboned appearance, the strata standing nearly vertically, and the separation between sandstones, shales, and clay slates being clear and well defined. After crossing the Irishman Creek the same succession of rocks continues, the only difference being that some beds of chocolate-coloured clay-slates, with a variety of brecciated sandstones (pebble beds), occur. I consider the presence of these beds of great importance, as assisting us materially in elucidating the geology of the Alpine regions in this Province. These beds occur repeatedly in going from east to west, and they will offer us a good horizon to divide the strata under review, by following and working from them in both directions.

The picturesque ranges between the sources of the Jollie and the Tasman Rivers, with their wild, fantastic forms, are also built up of the same rocks, and have a synclinal arrangement. In crossing the Tasman River on its broad and ever-varying shingle bed, we reach the Sealey Peak, where a great change in the character of the sedimentary rocks is soon observable. After crossing the usual indurated sandstones, shales, and slates of a truly sedimentary character on its eastern flanks, we see them succeeded by rocks of a more altered character, consisting of quartzose schists, foliated altered sandstone slates, green calcareous ferruginous slates, foliated argillaceous schists with quartz veins, siliceous schists, and true clay-slates, some of them resembling gneissoid schists.

Although I was not able to find a clearly defined contact line, so as to trace the relations of both beds to each other, I think—judging not only from the altered lithological character, but also from the difference in strike and dip—that the rocks which form the altered zone are underlying, unconformably, the indurated sandstones and shales, &c., of which the principal portion of the Southern Alps is composed: the more so if we take into consideration the character and position of the sedimentary beds which form the Moorhouse Range, and which closely correspond with those of Mount Cook and the adjoining Alpine heights. The altered rocks in the Sealey Peak reach to the Mueller Glacier. Having crossed the broken surface of the latter, we reach the foot of the Moorhouse Range, where, along some of the ridges and amongst the rocks on both sides of them, I ascended several thousand feet. The section obtained showed that here, as before observed, the same indurated sandstones and clay-slates occur again, dipping to the west, and, if we may judge from the neighbouring Mount Cook Range, showing also a synclinal arrangement. The western slopes of the Moorhouse Range, in the lower regions, consist, like those of the whole portion of the Southern Alps going westerly, and in descending order, first of siliceous schists, felstones, gneissoid and foliated schists, with diorites, melaphyres, and other eruptive rocks, succeeded by chlorite, gneissic and mica schists, the lowest beds of the whole series being gneiss granites and true gneiss. The whole appears as the eastern wing of a huge anticlinal arrangement. Near the western shores, and generally separated from the foot of the main ranges, low hills are situated, which in many instances rise in *roches moutonées* forms above the huge moraine accumulations. They consist of sericite slates and gneissoid schists, and are generally associated with or traversed by granitic, syenitic, and other plutonic rocks. On ascending the Mount Cook Range to an altitude of about 7,600 feet, I obtained also a good insight into its geological structure, the same succession of indurated sandstones, shales, and slates, forming a synclinal, also occurring here. On the highest point of ascent, a bed of serpentinous shaly slate, several hundred feet thick, occurs, interstratified between masses of fine-grained sandstones.

The only sign of organic life which I was able to obtain was a sandstone, with obscure remains of plants (fucoids?), occurring near the southern termination of the Mount Cook Range, near the junction of the outlet of the Hooker Glacier with the Tasman River. These beds repose upon sandstones, and are succeeded by clay-slates.

If we consider that these beds are all of marine origin, and, doubtless, of the same age as strata which in other parts of the world contain a great variety and quantity of fossils, it is difficult to understand what causes may have been in operation, either to deprive the sea-bottom on which they were deposited of animal life, or to destroy the exuviæ of the extinct inhabitants of those palæozoic seas so effectually as not to leave the least record behind. I shall return to this subject on a future occasion.

It is a well known fact that no locality offers a better insight into the character of mountain chains than morainic accumulations upon the glaciers, in which fragments of rocks that have not been subjected to much disintegration are carried down to lower regions upon the ice.

Thus, for instance, in the European Alps, interesting specimens of minerals and ores are collected among the loose *débris* upon the glaciers, and in the lateral and terminal moraines; and some important mines have even been opened by such means, the occurrence of valuable ores having been revealed by the moraine lines, and being followed up to the source from which the specimens had been derived. In other cases excellent localities for the collection of fossils have thus been discovered.

For the same purpose I devoted repeatedly many hours, during my different journeys in the Southern Alps, to a thorough search on the moraines upon the glaciers, and I did not neglect the same during my last journey.

During two days I examined carefully the whole breadth of the Tasman and Mueller Glaciers, but I am sorry to say without the least success. The only minerals I could find were calcareous spar, occurring in small veins in some of the indurated sandstones, and sulphuret of iron in small cakes in dark clay-slates.

The rocks were as barren in a palæontological as I had found them in a mineral point of view, the only trace of animal life being the tracks of Annelides upon a few blocks of clay-slates from the Hochstetter Glacier moraine. Some of the rocks contain small veins of ferruginous quartz, which might possibly be to a certain extent auriferous, owing to the diffusion of this metal in small quantities in some sulphurets; but I doubt if they will be sufficiently rich or extensive to lead ever to mining operations. We have therefore to look to the western slopes of the Southern Alps in this part of New Zealand for mineral riches, to which, judging from specimens which were submitted to me a few days ago for examination, we may now add sapphires and circons.*

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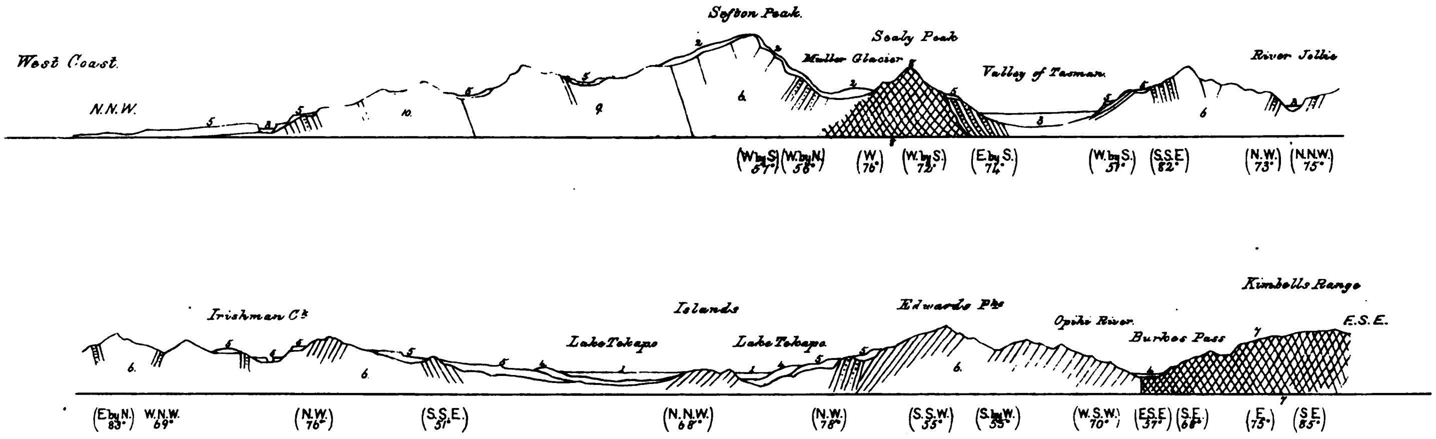
* A collection of 72 Rock Specimens accompanied this Report, and are deposited in the Colonial Museum.



FROM BURKE'S PASS THROUGH THE SOUTHERN ALPS (SEFTON P^{K}) TO THE WEST COAST.

To accompany Paper by D^{r} Haast.

1. *Lakes.*
2. *Glaciers & Snowfields.*
3. *Recent Alluvium.*
4. *Lacustrine deposits.*
5. *Glacier deposits.*
6. *Indurated Sandstones. Shales.*
7. *Foliated argillaceous & quartzose Schists.*
8. *Altered brecciated sandy Slates near Burkes Pass.*
9. *Gneissoid & foliated Schists. Felstones.*
10. *Gneiss-Granites. Gneiss & Mica Schists*

Scale 2000f^{t} to 1 inch Hor: & Ver:

ON THE GEOLOGY OF THE AMURI DISTRICT, IN THE PROVINCES OF NELSON AND MARLBOROUGH.

BY JULIUS HAAST, Ph.D., F.R.S.

28th May, 1870.

THE Survey of the above district was undertaken in accordance with a memorandum of instructions from Dr. Hector, from which it may not be out of place to quote the following passages bearing on the subject:—

"At the Amuri Bluff calcareous sandstone occurs, containing a variety of fossils, among which are Belemnites. Associated with these sandstones are coal seams and sandstones, and also calcareous rocks that are undoubtedly of the same age as our so called Miocene tertiaries in other parts of New Zealand.

"I would direct your attention to pages 17 and 34, etc., of the enclosed Report (*Progress of Geological Survey, for* 1866–67), and to the attached maps and vertical section.

"The object of your survey will be to discover the relation of these various beds to one another, identifying them if possible, by means of fossils and stratified position, with the Waipara beds that contain and overlie the Reptilian beds."

With this object in view I started, in the end of November of last year, direct for the Amuri Bluff, where I devoted a considerable time to the examination of the highly interesting beds occurring there, proceeding afterwards to the Kaikoura Peninsula, thence by the valley of the Coulterer, or Kahutara River, to the source branches of the Conway River, which I followed down to the sea.

After crossing the Caverhill Range to the mouth of the Waiau-ua River, I went afterwards to the Cheviot Hills and to the mouth of the Hurunui River, thus connecting the new work with former surveys in the Province of Canterbury, and returned to Christchurch by the middle of the month of January.

In February I started again, with the object of following the Waipara beds across the Hurunui Plains to the Culverden Hills, and then across the Waiau-ua to the ranges leading to the upper Conway, in order to become acquainted with the whole beds deposited in that former large Mesozoic bay.

Although, as will be seen from my report, I was not able to solve the question at issue entirely, the results of my investigations may not be considered quite unsatisfactory, because sufficient material for comparison and generalisation has been obtained during the course of the survey, to throw some light upon that interesting portion of the past geological history of this Island.

The Amuri District, in a topographical sense, may be said to be bounded on the northern and western sides by the slopes of the Seaward Kaikouras and their continuation on the southern banks of the Waiau-ua, the Tekoa Range, on the south by the River Hurunui, and on the east by the Pacific Ocean. From a geological point of view, however, we have to add to it that north-eastern portion of the Province of Canterbury, which is situated at the eastern and northern sides of the Ashley, embracing the mountains in which the Waipara takes its rise, and the hills and plains which form the banks of the latter river to the sea.

I will here state in a few words the principal orographical characteristics of this zone, with which its geological features are intimately connected.

The Seaward Kaikouras form mountains of 7,000 to 8,500 feet high, with a few deep but inaccessible saddles between them, running from near the mouth of the Clarence to the sources of the Conway River, where a deep break occurs, and where the younger Palæozoic or older Mesozoic rocks, of which the Kaikouras are almost exclusively composed, are succeeded by limestones of a more recent formation. If I have been rightly informed, it is possible to reach the northern banks of the Clarence, over this limestone zone, with comparative ease.

This break is situated between Mount Clear and the Sugarloaf, or Terako.

On the south-western side of this break, besides the limestone, trappean rocks now make their appearance, radiating in all directions in the form of coulées, or basaltic streams. South-west of Terako the older sedimentary rocks rise again in continuous chains, over which Jollie's Pass leads from the Hanmer Plains into the Clarence country. This chain is called in some parts Miromiro, or Perceval Range, and terminates on the the banks of the Waiau-ua River. South of this river the same rocks rise again to high ranges, continuing to the Hurunui, the principal one of which is called Tekoa.

The continuation of these mountains in the Province of Canterbury, is named the Paketeraki Range, from which lower hills, such as the Okuku Ranges, Cavendish Hill, etc., form the outrunning eastern spurs by which the Hurunui Plains are bounded on their western side.

All the rocks which form these mountains are of a truly sedimentary character, sandstones, slates, indurated shales, brecciated beds, and conglomerates, forming an endless succession of strata; at many localities diorites and amygdaloids are associated with them.

In the Mesozoic era these ranges formed a large bay, stretching from near the present mouth of the Clarence River to the slopes of Mount Grey, in the Canterbury Province. Numerous large islands were situated in it, consisting of the same rocks such as Mount Stuart, the Redan Mountains, Mount Parnassus, the Hawkswood and Caverhill Ranges, the Lowrie Peaks in the Nelson and Marlborough Provinces, and Mount Alexander in the Province of Canterbury.

Some of these islands were formerly much larger, dividing the younger beds, of which I shall speak presently, into different distinct zones. The rivers towards the end of the Tertiary period have cut through them in many instances. All these sedimentary rocks are very much jointed, having repeatedly undergone pressure of great intensity from various directions.

It may truly be said that after the mostly sub-aerial denudation of these mountains, probably after the deposition of the Triassic beds in New Zealand, the skeleton form of this portion of the South Island was already fixed, and that subsequent volcanic action, and the deposition of extensive younger beds, changed little the characteristic features of the country it had then assumed.

At the foot of these higher ranges we find next in age, sedimentary rocks, consisting of a coarse bluish or greenish sandstone, mostly with large perfectly spherical concretions of limestone of the same colour, which latter having generally better resisted the action of atmospheric influences, are often heaped together at the foot of the cliffs in such quantities as to resemble a large collection of cannon balls of all sizes. Interstratified with these remarkable sandstones, are quartzose slaty beds and a tough blue marlstone, with occasionally small beds of coal. This formation, which has been well described by Mr. Buchanan in his "Report on the Kaikoura District," *Geological Survey Report*, 1866–67, lies immediately upon the older formations, forming low hills, and seldom rising above those of the younger formations.

They repose nearly always unconformably upon the older rocks, having in some instances, as in the valley of the Coulterer, a synclinal arrangement. Generally, however, they occur in a denuded form, showing that they have undergone great changes before the next beds were deposited upon them. I have traced these rocks as far south as the Waiau-ua, but do not remember to have seen any of these cannon ball sandstones (as they were called by a shepherd in the Amuri), south of that river. No fossils have been discovered in them at present. They are also in some localities much more jointed than in others, and thus approach in appearance much nearer to the older rocks than to those sedimentary beds by which they are overlaid.

This marlstone formation appears conspicuously in the Amuri Bluff, where it forms a ridge over 700 feet high, being separated from the western range by a deep valley which has during the latter part of the Mesozoic period been filled up by younger deposits.

It evidently formed an island which stood in the Mesozoic sea, and suffered great denudation before it was protected by the younger strata deposited unconformably all round it. These younger beds were afterwards again removed on the northern side, by the action of the sea.

These marlstones stretch uninterruptedly towards the south to near the mouth of the Conway, diminishing in thickness and extent till they form only very small beds, on which the younger strata at the mouth of the Conway repose, apparently conformably. At the mouth of the Waiau-ua they disappear entirely, and only older sedimentary rocks occur, which form bold cliffs at the sea shore.

On the opposite side of the ranges however, near the junction of the Eden River with the Waiau-ua, they appear again in large beds.

On the northern side of the Kaikoura Peninsula, these marlstones are much less developed, and the overlying beds, which, with the exception of the limestones are also of very inconsiderable thickness, repose conformably upon them. Moreover, these two formations are blended with each other in such a manner that we must conclude that they have been deposited in sequence, without any break, or at least without the marlstones having suffered any denudation before the next formation was deposited above them. On the southern side of that peninsula however, they appear to be unconformable.

In the valley of the Kahutara, or Coulterer, where limestones appear in the centre forming isolated hills, we find that the marlstones form a synclinal, on which the Amuri Bluff beds, next to be considered, repose conformably. The high ranges on both sides which bound the valley, belong to the older sedimentary series.

Were we therefore to judge only from the appearance of the beds in that river as shown in section No. 9, we should conclude that both series, the marlstone and Amuri Bluff beds, belonged to the same formation. In any case it is apparent that the country had already received its present orographical main configuration, in so far that the broad valley of the present Kahutara and its connection with the upper Conway already existed, through which an arm of the sea flowed to the south before the marlstones and the succeeding beds were deposited.

The same rocks occur also in the middle Conway, but here again as in the Amuri Bluff, they must have been greatly denuded before the younger beds were deposited which repose unconformably upon them. Section No. 10 gives the details of this junction.

It would extend this report to too great a length were I to give from my fieldbooks, all the details I was able to collect of this interesting formation, I must therefore leave them for a future opportunity.

The newer beds which repose upon the marlstones, and which were the principal object of my investigation in the Amuri District, are of young secondary and tertiary age.

They may be divided into five main groups, of which the three first are apparently of young secondary, and the two last of tertiary origin.

The first zone is one of very great interest, consisting of a combination of rocks which seem to be confined to this part of New Zealand. It stretches in a S.S.W. and N.N.E. direction, beginning on the southern banks of the Hurunui, near the mouth of the Mandamus, and running, as far as I was able to trace it, to the Clarence, south-west of Mount Clear, the Sugarloaf, or Terako, which consists probably of basic rocks, belonging to the same system. On the western side it is bounded by Tekoa and the Leslie Peaks, on the eastern side by the Lowrie Peaks, Mount Parnassus and Mount Stuart on the right banks of the Conway, till we reach the low country in the upper course of that river.

This oldest zone of the beds under consideration, is about eight miles broad, and consists in ascending order, of shales or dark sandy clays, white sharp quartz sands and greensands, the whole capped by limestones, coral rag* or marble of white greyish or rose tints, with which in most localities, sheets of basalt full of grains or concretions of olivine are associated. Interstratified with the two latter are beds of basaltic tufa, sometimes brecciated, which are often cemented by carbonate of lime, and form rocks of singular beauty. They are evidently of submarine origin, as proved by the occurrence of fossil marine shells both in the limestone and tufa. Near the sources of the Mason River, one of the northern tributaries of the Waiau-ua, the limestone disappears, and only basaltic rocks in great masses, forming streams of considerable dimensions, cover the surface. Some of these are at least ten miles long, and proportionately broad and thick. It is doubtless here that the principal focus is situated from which the repeated eruptions have taken place.

About ten years ago I received a fine collection of fossil remains from the limestone beds of this zone, from Sir David Monro, which I sent to Professor McCoy, in Melbourne, who, after examining them confirmed my former opinion as to their Jurassic age, telling me at the same time that many of the fossils were identical with Australian species. As far as I am aware, these strata are, judging from the fossil remains they contain, quite distinct from the beds next to be described.

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* This appears to be a different formation from that to which the term coral rag is applied in the Waipara Report. See *ante*, p. 14.—J. HECTOR.

Besides this important fact, I wish to point out some other striking differences which distinguish both formations from each other.

The beds which I shall call in this report the Culverden or Jurassic beds have hitherto never been found to contain, either in Septaria, or loose in the sandy clays, any Saurian remains so abundant in the Amuri Bluff and Waipara beds, which, owing to the fact that the lower beds of these three series are quite similar in lithological character, is very striking and suggestive.

The sections, Nos. 17 to 28 will explain the general features of the zone under review. No. 17 will afford a good insight into the relations of the Jurassic beds with the older sedimentary rocks and the diorites, by which the latter have been disturbed and broken through.

I consider this section one of the most interesting and instructive I have ever seen in New Zealand, as the high and often vertical rocky walls, forming the banks of the River Mandamus, offer an excellent opportunity for examining the junction of all the different beds, from being so clearly exposed.

Thus it is evident that the eruption of the Diorites did not take place without great disturbance in the sedimentary beds, which in many instances were greatly faulted and fissured. When this new combination of trappean with sedimentary rocks had suffered great denudation, large beds of brecciated conglomerate, consisting partly of rounded, partly of angular pieces of different kinds of rock, were deposited on its flanks. The greater portion of the rocks from which this conglomerated bed has been formed has been however derived from the diorites. Sometimes it has almost the appearance of a friction breccia. In one locality in Coal Creek (a small tributary of the Mandamus), the details of which are given in section No. 28, a small seam of shaly coal, about 2 feet thick, is interstratified between this conglomerate.

The formation of the conglomerate beds was succeeded by the deposition of dark greyish argillaceous sands followed by coarse white sands; both beds are about 200 feet thick. Upon them, with a sharply defined boundary, repose calcareous greensands about 30 feet thick, the whole protected by beds of coral rag, of a thickness of 30 to 40 feet, and of a white or yellowish colour. Some of the beds have a red tinge, probably from rubefaction. All the lower beds have hitherto proved to be unfossiliferous, and only the coral rag contains a few, generally indistinct, shells, of which I shall speak presently.

The coral rag in the Mandamus is not covered by coulées of basalt, as in other parts of the district, but it is evident from the numerous basaltic dykes which cross the diorites and the older sedimentary rocks, that the eruption of that basic rock took place at a much later period than when the diorite, which sometimes resembles a syenite, made its appearance.

In the section, No. 27, drawn on a larger scale than most of the others, I have shown from a sketch made on the spot, the true size and position of the basaltic dykes crossing the diorites in every direction, which proportions in the large section of the district I could not give, being obliged for the sake of clearness to exaggerate somewhat the basaltic dykes which are generally between 1 and 5 feet broad.

In the same section which I have extended across the Hurunui to the Waipara, I have shown the position of the Saurian beds in that latter district, and I shall return to this subject towards the end of this report when comparing the relative ages of the different beds.

Crossing over to the Pahau River, a tributary of the Hurunui, we find ourselves, with the exception of the higher ranges on both sides, entirely in Jurassic beds.

I have endeavoured in selecting section No. 19, to show the diversity of the rocks and the changes which have taken place through denudation and other causes. We here observe the coral rag limestone repeatedly covering the basaltic tufas, breccias and basalt, again overlaid by coulées of basalt. Some of the tufas change into glauconitic beds, and contain marine fossils. Sometimes the limestone is also full of grains of glauconite.

In the banks of the Pahau, I collected in these beds, two species of Pecten, and a Terebratula which is very common in them.

Where the Jurassic beds have been removed the space has been filled up by much younger beds, mostly standing at a high angle.

They consist of bluish argillaceous sands or sandy clays, with harder beds formed of shell sandstone or earthy limestone, occasionally interstratified between them. Some of these beds are full of fossils in great variety, and in a splendid state of preservation. They are of Tertiary age, and contain, besides many other species, a large Turritella, Pecten, Pectunculus, Cucullæa, and Struthiolaria, I shall call them in these notes, the Turritella beds instead of the Cucullæa beds as I did formerly. My reason for thus changing the nomenclature is that also in the older strata a large Cucullæa is of frequent occurrence, which might lead to confusion.

An examination of the different sections will show that these Tertiary strata are very largely developed in many parts of the district under review. However, owing to their softness, unless protected by favourable circumstances, they have been again removed, so that in many localities not the least trace of them remains.

It also appears, from the fact that no other beds are deposited between the Jurassic and the Tertiary strata, that after the formation of the coral rag beds or the last eruption of the basaltic rocks, the whole country emerged from the sea and remained dry land for a considerable time.

Returning to the section, No. 19, we find a very interesting locality in the banks of Black Birch Creek, a small tributary of the Pahau, in which the Culverden beds have been protected by a stream of basalt.

The lowest bed consists of bluish sandy clays, which are, on the surface bleached white. They are succeeded by loose sharp white quartz sands, upon which repose about 30 feet of greensands. Instead of being overlaid by the coral rag or marble as in all other localities which I visited, they are succeeded by calcareous sandstones interstratified with marly shales. Each bed is of a thickness of 6 inches to 12 feet, the sandstones being the thickest.

This calcareous sandstone, which is a good freestone, has been used with great success for mantlepieces and other ornamental work, and I may here add, that although the coral rag is generally much jointed or subdivided into thin layers, there are some localities where it forms large blocks which would afford fine material for building purposes. This calcareous sandstone also claims our attention from being fossiliferous. I collected here several species of Pecten, a Terebratula, Teredo, Cidarites, and a Terebella resembling the Terebella lapilloides of the Oolite (White Jura). There are also some excuviæ, mostly fragmentary, which appear to be parts of Ammonites; this is the only locality where I met with them. I have no doubt that this spot would yield, during a longer and more minute search than I was able to make, many more interesting fossils, and would throw more light upon this formation.

The Culverden section, No. 18, which I extended across the Hurunui Plains so as to pass through the Isolated Hills on the southern banks of the Waiau-ua, exhibits well the repeated eruptions of basalts after a considerable interval, during which the formation of the limestones took place. The uppermost bed of the coral rag consists often of a mass of shells, cemented by small pieces of coral; the former are however difficult to get out entire.

It was from this locality that Sir David Monro made the collection which I sent to Melbourne. I also collected on this occasion some interesting specimens; amongst them are, Pecten (3 species), Spirifer, Serpula, and some others. The collection of Sir D. Monro contained also the bony spine of a fish, like Hybodus, and some teeth having the form of those of Acrodus, besides Terebratula pseudo-lenticularis and Terebratula pseudo-cruenta, *McCoy.*

In the section obtained in the Isolated Hills, no basalt appeared, but a bed of basaltic tufa occurs, which separates two beds of coral rag limestone, by which the summit of the range is formed. On both sides of these strata, Tertiary (Turritella) beds of great thickness appear, standing on the western side at a high angle.

As before observed, they have been denuded to a great extent, and on the top of them reposes an alluvium older than the post-pliocene alluvium of which the Canterbury and Hurunui plains are composed. The older alluvium consists generally of smaller pebbles than the younger beds of the same origin; it occurs generally in a higher position, and is sometimes lying at an angle of 10° to 20°.

In the section, No. 22, the older shingle deposits are at an inclined position of 10° towards south. Between the layers of river shingle, sandy clays and loess are interstratified, which are more hardened than the so called post-pliocine beds generally are.

I may here observe, that during the whole journey I failed to trace any signs of glacier action in any part of the district, either in the valley of the Waiau-ua or in the Conway and Coulterer. I had expected from the altitude of the Seaward Kaikouras, that at least toward the upper portion of the valley of the last mentioned stream, morainic accumulations would occur, bnt I did not find the least trace of them anywhere. Neither could I detect any signs of glaciation in the Hanmer Plains, although it appears, from observations made by Mr. Travers, that higher up the valley of the Waiau-ua ample evidence of huge glaciers in post-pliocene times is found. It therefore seems evident that the Seaward Kaikouras and the other ranges in the Amuri district, were of too small dimensions for the formation of large glaciers, and the neighbourhood of the sea doubtless assisted in reducing the nevés to such an extent, that only glaciers of the second order could be formed. It is true I observed some traces near the mouth of the Coulterer, on the southern side, which had all the appearance of old glacier shelves in our Alps, but the stratification of the rocks might in this case have produced that appearance.

There is, however, a small range of isolated hills, lying on the northern banks of the Coulterer, near the sea, named the Lake Hills, in which several large and small lakes or lagoons are situated, which might possibly throw some light upon this question. I had no time to visit them, except on their western side in passing by, but think they will consist principally of beds belonging to the marlstone formation.

Another interesting part of the Jurassic beds is found ten miles north of Culverden, in the picturesque valley of the Waiau-ua River. In this locality, a basin existed amongst the older sedimentary rocks, into which the lower beds of the Jurassic formation must have been deposited, after which a volcanic outburst took place, forming a boss of basalt, over which basaltic tufa beds were deposited, the whole being covered by a bed of hard coral rag limestone, forming a dome-like hill in the centre of the valley. The eastern portion of this dome has been removed, and only the western half remains, standing out boldly as Marble Point Hill. Another cause for the disappearance of the eastern portion, may be traced in the occurrence of a fault in which the river now flows, and by which the position of some of the beds was changed, as will be observed by comparing the sections, Nos. 24 and 25, with each other.

As I stated previously, the main seat of the eruptions was situated north of the Waiau-ua, near the sources of the River Mason.

I examined one of the large streams of basalt which flow in all directions from this centre; this stream, called Redspur, abuts at its termination about two miles north from Lyndon, against older sedimentary rocks, where the basalt is accompanied by beds of large bright red tufa, from which the hill has derived its name. In Counting Creek, running west of Redspur, besides coral rag limestones, trachytic porphyry occurs higher up. A wide valley, filled with Turritella beds, which stand sometimes at an angle of 80°, lies between the Redspur stream and Mount Cookson, the next eastern basaltic range, which rises at least 1,500 feet above the valley.

The lower portion of this range consists of basalts and basaltic tufas, and the upper part of fine coral rag limestone and marbles, which are here full of funnel-shaped hollows.

It is over this mountain and its northern continuation, the Whaleback, that the waters of the upper Conway are reached.

I have added several sections in illustration of the geological features of this very interesting locality, to which I wish to refer the reader.

The next series, which I shall designate in this report the Amuri Bluff Beds, in which locality they are most extensively developed, have no eruptive or volcanic rocks associated with them. They consist, in ascending order, of shaly beds containing sometimes small irregular seams or patches of Brown coal, generally full of iron pyrites, and overlaid by a considerable thickness of white quartz sands, which are generally traversed, at great intervals, by thin beds of calcareous fossiliferous sandstone, containing the remains of mollusks, fishes, and saurians, of many genera and species, often in a fine state of preservation.

The lowest of these sandstone layers is 8 feet thick, the lower half being unfossiliferous, whilst the upper portion is often one conglomerated mass of organic remains. Amongst the shells several species of Trigonia, Inoceramus, Cucullæa, Arca, Pecten, Mytilus, Leda, Astarte, Panopæa, Vermetus, Teredo, and a Dosinia, identical with our tertiary Dosinia Greyi, are the most important. A rolled up Serpula also occurs, which might at first sight be mistaken for an Ammonite. Of Cephalopods no Ammonites could be discovered, but a Belemnite resembling B. hastatus is very abundant throughout these calcareous sandstones. In some layers these Belemnites, often rolled and broken, are mixed up with the other shells, and lie in all directions upon each other. In other spots they form well defined layers, from 2 to 4 inches thick, stratified quite regularly, in an otherwise unfossiliferous bed. Gasteropods are rarely to be found, and only a few rather indistinct shells resembling Cancellaria or Neritopsis, and a Rostellaria (or a winged Struthiolaria), occur occasionally. Numerous fish teeth are scattered throughout the mass of shells, belonging to species allied to Otodus, Hybodus, Lamna, Notidamus, etc., and I also obtained a few scales of fish allied to Lepidotus.

A few larger teeth of saurian character are enclosed in the same matrix, together with rolled vertebræ and other fragmentary remains of true Enaliosaurians.

The white quartz sands, of a thickness of several hundred feet, become argillaceous towards their upper portion, where they are generally covered with an efflorescence of sulphur on their exposed surface.

They then resemble closely the Septaria beds higher up in the series, if we accept the absence of the calcareous concretions, so common in the upper beds. They gradually change into loose greensands, which contain little lime, and are of considerable thickness.

These glauconitic strata are divided into two portions, by the occurrence of a bed of conglomerate, 6 to 8 feet thick, consisting mostly of small pebbles of chert and sandstones belonging to the older series, but the marlstones are also represented. Occasionally a few white translucent quartz pebbles are also enclosed, the whole being cemented by carbonate of lime. This interesting bed yielded a great number of teeth and vertebræ of fishes and saurian remains, the latter generally rolled. Remains of mollusks are not of so frequent occurrence, and when present are identical with those of the lower beds. On the summit of the Bluff on Ward's Hill, this conglomerate consists generally of larger pebbles, almost boulders, but still of the same material as near the tideway. It also contains remains of shells, some of them of considerable size, such as Inoceramus, Trigonia, Pholadomya, and Chama (?), but generally only in casts.

These greensands change gradually into sandy clays, either ferruginous or sulphurous, which contain at the beginning of the bed only a few Septaria, but as we follow it upwards they become more frequent, until, in some localities the whole banks are studded with them.

These Septaria are from 1 to 12 feet in diameter, generally perfectly round, and contain, in or near the centre, either one single saurian bone, part of a skeleton, which in this case lies with the principal diameter of the concretion, or some other organic body.

At some spots the whole beach literally consists of Septaria, of all sizes, partly broken and partly entire. The split ones generally exhibit some organic remains in or near the centre. Sometimes they have been cracked and are cemented together by carbonate of lime, which also passes through the saurian remains if present. There is not the least doubt that these Septaria, like those in the Waipara, consisting of a fine grained blue tough limestone, were formed *in situ* around the organic remains which they enclose.

The collection I made here includes the portion of a skull (Ichthyosaurus?), several large humeri of Ichthyosaurus and Plesiosaurus, vertebræ, both bi-concave or concavo-convex, belonging also to different genera, phalanges, etc.

Compared with similar bones from the Waipara, they are generally of much larger dimensions, and probably of different species. I wish, however, to make this latter remark with great diffidence, as I had no time to compare them with each other, as I transmitted them shortly after my return to Christchurch, together with all the other fossils, to Wellington.

In the Septaria, a few shells and teeth and scales of fishes are occasionally found. A few irregular, or lenticular, beds of calcareous sandstones occur, also sometimes in these Septaria clays, which towards their upper part become more marly. They are many hundred feet thick, and are of larger dimensions in the Amuri Bluff than I have seen anywhere else in the district.

They are succeeded by yellowish arenaceous sands, alternating with bands of yellow calcareous sandstones, a little glauconitic, the latter forming protuberances in the face of the cliff. These two beds are about 20 feet thick, and are overlaid by a yellowish arenaceous limestone. The latter contains irregular layers, or pockets, of quartz sands. A bed of loose glauconitic sands, about 7 feet thick, follows, covered by yellowish calcareous sandstones, about 20 feet thick.

All the fossils in the beds above the Septaria clays, appear to be distinct from those obtained in the latter. A Terebratula is frequent, and a Vermetus, Teredo, and a few spines of Cidarites, with some fish teeth, are also occasionally found.

The Great limestone formation of the Amuri Bluff then follows, consisting of a fine grained or compact flaggy limestone of light colours, either white, grey, or light yellowish.

Fossils are very rare, and I only obtained some stems of Pentacrinites, a Terebratula, and a few teeth and vertebræ of fish. Some of the beds, however, contain burrows of Annelides, others numerous specimens of Vermetus and Teredo.

In some localities small concretions of iron pyrites stain the rock by their decomposition. These limestones become gradually more earthy, and form large beds of a bluish earthy marlstone or chalk marl, which, as far as I examined it, is unfossiliferous, with the exception of some localities where it contains impressions and casts of large fucoids.

It appears to me, and subsequent examinations in the Conway have confirmed me in this view, that these marly or earthy limestone beds have been deposited in sequence upon the compact limestones in the Bluff. I shall, however, return to this subject when speaking of the Conway section, where these beds are also largely developed.

These marly beds which form the south head of the Amuri Bluff, end the series. On the western side of the Bluff, and upon the marlstones previously described, nearly the same beds are met with as on the eastern side, the difference being in the first instance, that the shales are of greater thickness and the sandy strata more variegated, namely, white and greyish or white and greenish beds, sharply defined, alternating repeatedly with each other.

The calcareous sandstone bands are generally not continuous, but form lentil-shaped beds, containing the same fossils as on the eastern side.

Moreover, some of these beds consist of a shell conglomerate, formed by a gasteropod like Aporhais, or a winged Struthiolaria (Rostellaria).

The cement beds occur in a similar position on this side, and Septaria clays are also present, frequently containing here, however, besides saurian remains, roots and portions of stems of coniferous trees, silicified.

The limestone beds, of great thickness, resemble in lithological character those on the eastern side, with the exception that they contain a great many concretions of flint, which makes them less valuable to the lime burner than those obtained on the eastern side, which are largely shipped to Lyttelton.

The Amuri beds form a synclinal on the western side of the marlstone formation, which is well exhibited by the limestones along the coast line.

The upper beds of earthy limestones are here missing, and instead of them glauconitic calcareous sandstones repose upon them, containing spines of Cidarites, and a Terebratula.

This bed probably represents strata of similar character, largely developed in the Kaikoura Peninsula and Gore Bay, which I shall call the Scalaria beds in these notes, and of which I shall speak more fully when treating of the beds in the last mentioned locality. The Amuri Bluff beds on the eastern side, which dip at an angle of 22° to 25° to the south-east, stand on the summit of the Bluff much more inclined, namely, 41° to 48°.

Advancing towards south they become still steeper, so that their dip near the Boat Harbour is as much as 75° towards east.

The limestone runs for nearly half a mile along the sea beach, usually covered by sand, until it enters the sea, forming a series of cliffs, generally covered at high-water, by which when the sea is calm an excellent boat harbour, three miles north of the mouth of the Conway, is formed.

The detail sections, Nos. 2 and 3, show the position of the beds and their similarity to those in the Amuri Bluff.

About two miles south of that promontory the formation leaves the sea shore, and crops out again on the northern banks of the Conway; the details of this are given in section No. 4.

The dip of the beds has again diminished to 45° to south-east, and while the limestones and the overlying fucoid beds are still of considerable thickness, the lower beds have dwindled down to much smaller proportions. Septaria clays with saurian remains are still present, but the fossiliferous calcareous sandstone layers in the white sands are now missing.

On the southern bank of the Conway the Amuri Bluff beds entirely disappear, being probably hidden under the large post-pliocene shingle terraces which face the mountain sides, and make their appearance again three miles south of the mouth of the Waiau-ua River, in a few cliffs washed by the surf.

The Kaikoura Peninsula consists principally of strata belonging to the same formation, but, as before observed, the lowest beds are very small, the limestones greatly preponderating, and containing the same fossils as in the Amuri Bluff.

The whole seems to have been deposited upon a submarine rocky shallow, the newer beds following all the outlines of the underlying rocks, which were gradually sinking into deeper water. They in their turn have been subjected to considerable denudation, mostly by marine agencies. On their denuded surface, younger strata of tertiary origin (Scalaria beds) have been deposited, which will be more fully described hereafter.

The Amuri Bluff beds occur also about half way up the Conway River. They are here apparently cut off from the Culverden beds by a ridge of old sedimentary rocks, which runs from Mount Clear towards south, and through which the Conway has cut its way. However, as I did not go to the source of that river, the time at my disposal being too short for that purpose, I wish to draw attention to this important region which has still to be investigated, as the junction of the Culverden and Amuri Bluff series may be found here.

Ten miles from the mouth of the Conway, the older sedimentary rocks cease, and marlstones and Amuri Bluff beds again make their appearance. The sections, Nos. 10, 11, and 12, give the details of this interesting basin, which stretches to the Caverhill Range and Mount Parnassus.

The Amuri Bluff beds repose here unconformably upon the marlstones on the western banks of the river, while on the eastern they lie upon the older sedimentary rocks, the marlstones being missing.

They are of far less thickness than in the Amuri Bluff, but the lower beds still have calcareous sandstone layers dividing them, containing the same fossils, although now much scarcer. I also found a few Belemnites amongst them.

The conglomerate or cement bed, with saurian remains and fish teeth, is also present.

The large Septaria however all contain, as far as I was able to examine their interior, silicified wood.

The limestone series, beginning with glauconitic marly limestone, and becoming gradually pure white and fine grained, presents some very interesting features, as shown in the sections, Nos. 10 and 11.

The lowest limestone layers have been deposited without disturbance, but seem afterwards, on the western side, to have been folded up in a most remarkable manner, after which newer beds of the same rock have again been deposited, reposing unconformably upon the lower beds.

This fold does not occur on the opposite eastern side, but the unconformity between the upper and lower beds exists there also. No eruptive rocks, by which this remarkable folding might have been caused, are any where visible, although in following up the small limestone creek joining the Conway south of these beds, boulders of basalt are met with, the origin of which I was however unable to trace.

The uppermost beds of the limestone which have hitherto been tabular or flaggy, containing the same species of fossils as in the Amuri Bluff, now become nodular, and contain nests and streaks of greensands.

In this stratum I collected a Terebratula and teeth of Lamna. It is overlaid by sharply defined beds of greensands, which appear on both sides of the river, and repose conformably upon the nodular limestones.

Argillaceous sandy beds of great thickness follow, containing hard bands of calcareous sandstones, which seem to be unfossiliferous; they gradually become more calcareous, and contain the same peculiar fucoid casts as those collected in the Amuri Bluff. Towards the centre these beds change into marly clays, containing a few very fragile fossils, amongst which a Leda is predominant.

The strata forming the uppermost beds of the whole series are sandy clays. Following the river towards the lower gorge, the underlying strata appear again in their succession, ending with the greensands, after which large beds of post-pliocene shingle conceal the rest.

However, on the eastern side of the basin above Hawkswood, the picturesque residence of Mr. Caverhill, a few layers of calcareous sandstone, approaching the Waipara or Weka Pass beds in character, show themselves among alluvial deposits, which may possibly be the representatives of the Amuri Bluff limestone. I have to refer more fully to this subject when treating of the geological features exhibited in the Mount Caverhill section.

The principal feature in this section, No. 13, is the enormous thickness of the older sedimentary rocks, overlaid on the eastern side, near the foot of the range, by marlstones.

In descending the range towards the junction of the Eden with the

Waiau-ua, 600 feet above that river, the hill sides are generally so covered with alluvium, or are so thickly overgrown by vegetation, that no bare rocks are visible. In some localities, however, boulders of a bluish hard limestone lie on the surface, and in some slips more to the west, clay marls and ferruginous quartz sands are exposed.

Before descending into the valley, a coarse conglomerate crowns the lowest rise of the spur, in which a considerable number of remains of saurians and fishes are enclosed, resembling in character those found in the Amuri Bluff. No shells or Belemnites are embedded in the same strata, so that in order to prove their age we have to rely entirely upon the remains of higher organization.

After leaving this fossiliferous conglomerate, and crossing a broad valley, we meet for the first time the Weka Pass beds proper, a calcareous sandstone of peculiar texture, and quite distinct from the limestones hitherto described. Advancing towards north, the distance between both beds gradually diminishes, till the sandstones join the conglomerate, on which they repose unconformably.

Another valley separates these calcareous sandstones from the Tertiary Turritella beds, which also join the Saurian beds in the same manner.

I may here observe, that this calcareous sandstone bed can be traced from this point, without interruption, across the Waiau-ua and Hurunui into the Province of Canterbury, and thence to the Waipara.

Another continuation of the Waipara beds can be traced as far as the Hurunui, where the southern support of the bridge rests upon it; they are, however, not found on the northern side of that river.

Consequently, a large valley separates them also in this part of the Amuri district from the Culverden beds.

Another instructive section is No. 16, along Gore Bay, in the Cheviot Hills. Although it appears that the lower beds on both sides are of the same age, being the two wings of a synclinal arrangement, they are in many respects dissimilar in sequence and character. Beginning our examination on the northern banks of the river bed, we first meet with calcareous sandstones alternating with black slaty shales belonging to the older sedimentary formation. The lowest bed of the newer series reposing upon them, consists of a peculiar greensand conglomerate, about 3 feet thick, which is succeeded by sandy beds more or less glauconitic, in which calcareous unfossiliferous sandstones, forming lentil-shaped layers, are interstratified.

Above them occur glauconitic sandy clays, containing saurian remains, which are however not enclosed in Septaria, but stick loose in the clays, so that they can be removed without much difficulty. I obtained here part of the sternal apparatus of a large saurian, either Ichthyosaurus or a closely allied genus, together with the left humerus, ulna, radius, the carpal, metacarpal, and some of the phalangal bones belonging to it. This humerus, in a fine state of preservation, is 14 inches long and 9 inches broad.

Unfortunately, during my excavations, heavy rain began to set in, which compelled me to leave them for several days, the river rising above the spot where the bones were exposed. When on the fourth day I was able to return, part of the bank where I had been at work had been washed away, and consequently a considerable portion of the sternal apparatus had been lost.

The two coracoid bones measured 2 feet 9 inches across.

No fossiliferous sandstones occur in the lower beds of the Jed, like those in the Amuri Bluff or Waipara River, by which that locality could be connected with either of them, but as I have obtained carpal, metacarpal, and phalangal bones in the Waipara, belonging to the same species as those found in the Jed, there is no doubt in my mind that both beds are of the same age. This palæontological evidence is therefore of great importance.

Further excavations in the same locality will, no doubt, still yield considerable portions of this interesting saurian, the skull of which has been washed away by the river in forming its present bed.

These sandy clay marls contain also numerous arenaceous concretions, some of which are of a coprolitic form.

In quartzose bluish sands which immediately overlie the Saurian bed I also obtained, lying loose in them, a vertebra with spinous process of another saurian with a more plesiosaurian character.

Several beds of micaceous dark clays follow, after which calcareous sands changing into white quartz sands form large beds.

They are succeeded by greensands, changing into chalk marls, but instead of being succeeded by calcareous sandstones as is usually the case, they alternate repeatedly with yellowish quartz sands, before the Weka Pass stones make their appearance.

These latter beds are in the northern part of the section covered unconformably by Turritella beds.

On the southern side, in Gore Bay, the strata are somewhat different. The greensand conglomerate reposes here also directly upon the older sedimentary rocks, upon which very dark (almost black) greensands with

Septaria follow, which are missing on the western side of the section. In one of these Septaria, which are as it were irregularly interstratified in the dark beds, a large silicified piece of wood formed the centre.

These dark greensands are overlaid by similar beds, but of lighter colour and without any Septaria, separated into several layers by hard bands of blue unfossiliferous calcareous sandstone. The next bed consists of sharp white quartz sands which is, in its turn, overlaid by limestone, at first a little glauconitic, but afterwards becoming more compact and white, subdivided by small layers of loose calcareous sands. In its lower portion this limestone resembles the Weka Pass beds, whilst the upper strata have the character of the compact white limestone of the Amuri Bluff.

Marlstones are nowhere visible in the district, but near the centre of the section, where the limestones form a reef running into the sea, a great number of the spherical concretions from the marlstone sandstones lie in the tideway, so that we have some evidence that this formation is not missing, and probably forms reefs in the neighbourhood below the surface of the sea.

On both sides of this section the limestones are overlaid by Scalaria beds, previously alluded to.

On the northern side the junction is covered by landslips and alluvium, but on the southern side it is clearly exposed.

A small layer of greensand conglomerate, similar to that by which the older sedimentary rocks are covered, separates these younger Scalaria beds from the limestones, to which they are quite conformable in strike and dip. This conformity is however only accidental, as in other localities where both beds occur together, the reverse takes place.

These Scalaria beds are of much younger origin than the limestones, either in the Amuri, Conway, Kaikoura Peninsula, Gore Bay, or the Waipara, as they have generally only been deposited after the older beds had been subjected to great denudation, as shown in section No. 8, although in many instances the planes of the stratification of the limestones, having best resisted the denuding agencies, have remained intact.

The lithological character of these Scalaria beds is nearly alike everywhere. Glauconitic earthy limestones were generally first deposited, followed by calcareous sandy marls with small bands of blue hard calcareous sandstone capped by loose quartzose sand, either a little ferruginous or with a slight admixture of lime. In Gore Bay they are several hundred feet thick. They contain besides a Scalaria, teeth of Lamna, and numerous spines of Cidarites, closely resembling those of

Cidarites nobilis, Histrioides, Trispinatus, all occurring in the White Jura of the northern hemisphere. Thus, were we to judge from these latter fossils alone, we should have to assign to these beds a far greater age than they really possess. I may add, that casts of fucoids, similar to those in the Amuri Bluff, also exist in these beds; an important fact which we must not overlook, as the occurrence of these peculiar markings connects both beds with each other.

These Scalaria beds are also extensively developed in the Waipara, where they repose in a similar manner upon the calcareous sandstones (or Weka Pass series).

They have, in their turn, suffered considerable denudation, and Turritella beds have been deposited over them, containing the same fossils both in Gore Bay and the Waipara, as in the localities previously alluded to.

These latter strata having been raised high above the level of the sea, were now subjected to denuding agencies, in Gore Bay to the action of a river of considerable dimensions, which not only cut its channel into them, but deposited beds of shingle and sand of considerable dimensions in the space thus excavated. These deposits consist of true river shingle, mostly derived from older sedimentary rocks, with occasionally a few pieces of chert and white quartz, but I was not able to find either marlstones, limestones, or other younger rocks amongst them.

From the position of the pebbles it appears that the river which formed these beds had an east and west direction.

Having alluded to all the formations found in the district under review, I will now add a few observations on the Waipara District, to which locality I paid another visit, principally with a view of examining the fossiliferous beds more minutely than I had hitherto had an opportunity of doing.

Being anxious to find what I had hitherto failed to obtain, namely, fossils identical with those from the Amuri Bluff, I devoted several days to collecting in the bed of the Waipara River and in Boobie's Creek from the layers of calcareous fossiliferous sandstone which occupy the same position in those localities as in the Amuri.

Before however proceeding further, I will point out that the lithological character of the rocks in both regions is nearly the same, the difference being only, that the conglomerate beds of the Amuri Bluff do not occur in the Waipara, and that the Septaria clays of the Waipara, nearly of the same thickness as in the Amuri, are overlaid by very thick beds of true greensands which are missing in the last mentioned locality, a point to which I shall have to refer again.

The result of this examination tended to confirm the fact that all the fossils are quite distinct in both localities, with the exception of the Dosinia so common to the whole series, the Turritella beds included, and of a Trigonia which I had not found before. There are also a few teeth of fish which may belong to both localities.

If we consider that both beds were deposited under similar circumstances, it is almost impossible to conceive that they are of the same age, unless we assume that peculiar reasons might account for such a remarkable diversity of animal life, as for instance that a small strip of land, resembling the Isthmus of Suez or Panama of the present day, separated two seas with perfectly distinct faunas, and as the genus Trigonia is still living in the Australian seas, the occurrence of this shell alone might therefore not give a secondary character to the Waipara beds. I may however add, that I obtained also a few fragmentary shells, probably belonging to the genus Inoceramus, which might strengthen the evidence in favour of secondary age.

A peculiar Gasteropod, Conchotyra parasitica, *McCoy*, which is not only exceedingly common in the fossiliferous beds of the Waipara, but which is also frequently enclosed in the Septaria, either alone or in company with saurian remains, is entirely missing in the Amuri district. In the thick greensand strata overlying the Septaria clays in the Waipara, I obtained some fossil shells which appear to be allied to Radiolites, the occurrence of which may therefore point to an upper cretaceous age. This important fact in connection with the occurrence of the few fossils before enumerated, compels me to modify my views concerning the age of the Waipara beds, always supposing that the Radiolites-looking bodies belong to that genus of extinct cretaceous conchifera.

It also appears to me that the fossils found in the limestones, both in the Waipara and the Amuri Bluff, belong to distinct species, but this may easily be accounted for by the difference, in lithological character, of both rocks, they having probably been deposited under different conditions; I wish, however, once more to point to the fact that the Waipara calcareous sandstones (Weka Pass beds) thin out as they advance towards north, that in the Hurunui Plains they stop short on the southern side of that river, near the bridge, and that near the sea where they cross that river, they also diminish gradually till only a small bed lies unconformably upon the conglomerate beds of the Amuri Bluff series, about a mile north of the junction of the Eden with the Waiau-ua River.

Before the question of the relative ages of these different geological formations can therefore be definitely settled, the saurian remains collected in the various localities must be compared, and some more detail examinations have to be made in the beds which reach from the mouth of the Hurunui to the Waipara, and in which conglomerates occur at a few localities. I also wish to point to the middle Waimakariri basin for a detail survey, where I expect that a solution to some of the questions at issue may be found.

ON THE GEOLOGICAL STRUCTURE OF THE MALVERN HILLS DISTRICT, CANTERBURY. BY DR. HECTOR.

25th November, 1869.

The Malvern Hills, situated forty miles west of Christchurch, form the western limit of the Canterbury Plains, and lie between the Rakaia and Waimakariri Rivers. They extend in length for about eighteen miles in a N.E. direction, and their width, if they are considered to extend to the base of the Big Ben Range, is about ten miles.

The district thus defined is remarkable for its variety of geological structure, and from coal and indications of metallic minerals having been found, a great deal has been anticipated from it as a source of wealth to the Province.

The general geological structure of the district has been ably given in a report by Dr. Haast,* and the following notes which relate more particularly to the value of the coal seams, are the result of a rapid inspection of the district in October, 1869.

There is reason to think that the thickness of the Pleistocene gravel formations along the base of the mountains cannot be very great, except in the course of the greater river valleys, but except at the "Curiosity Shop," on the left bank of the Rakaia, five miles out in the plains, the nature of the rocky floor on which the gravels rest, is not exposed to observation. At this point the lower portion of the terrace cliffs is formed of white calcareous sandstone, containing the fossils characteristic of the Ototara series, belonging to the older tertiary period of New Zealand. Excluding from consideration this isolated mass, the first outcrop of strata from beneath the shingle deposits of the plains, is seen about four miles above Mr. Hall's station on the left bank of the Hororata River, as a series of *dark coloured ferruginous clay shales*, dipping eastward, containing hard, sandy concretions, that show fragments of

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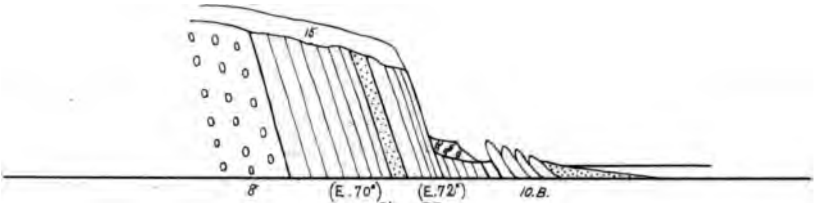
* Canterbury Government *Gazette*, 23rd September, 1863; also in MS. Geological Maps and Sections.



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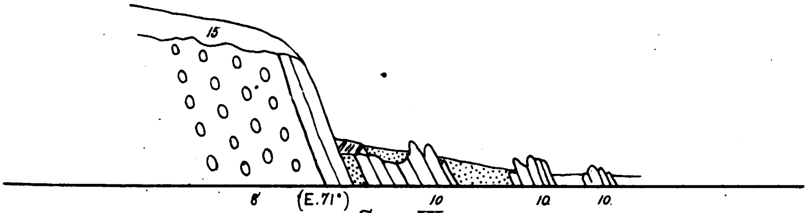
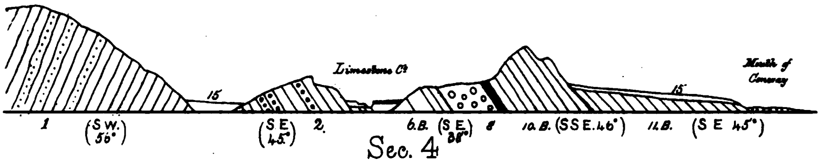


Sec. III



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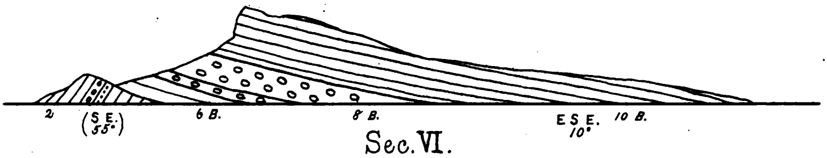

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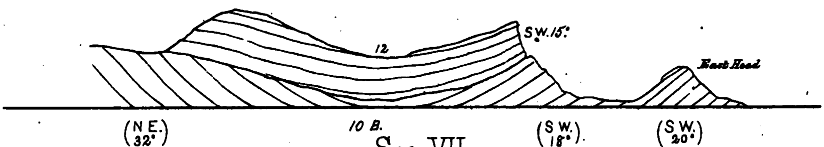

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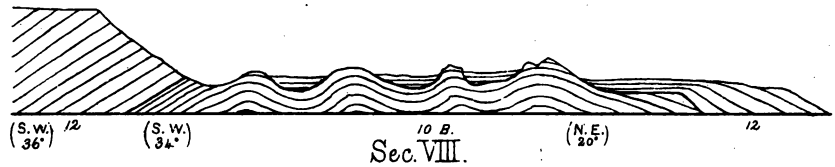

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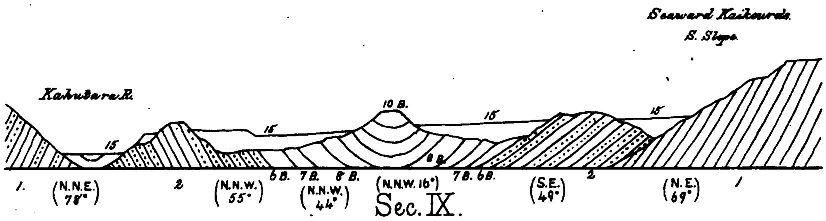

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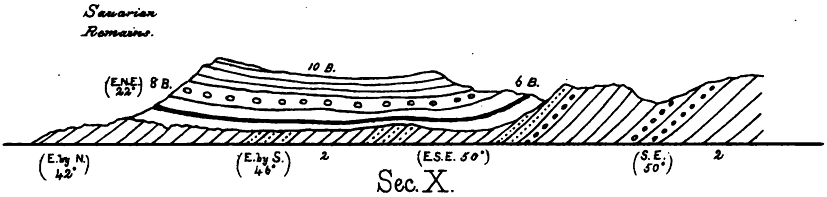

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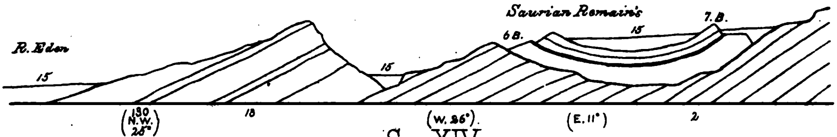

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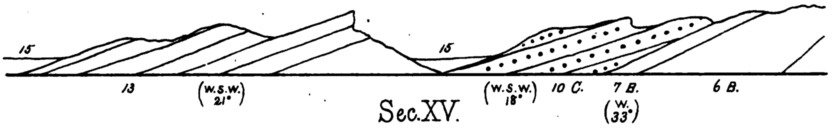

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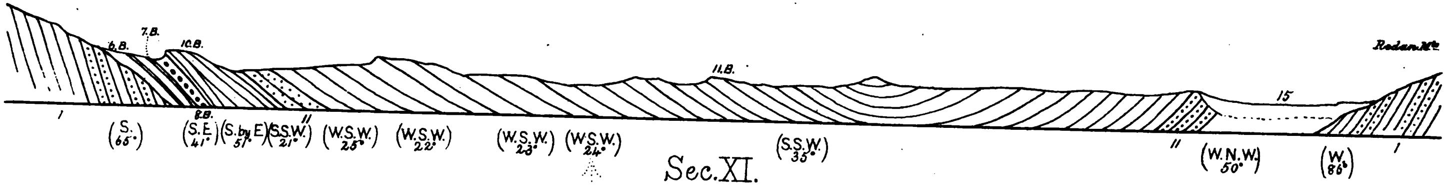
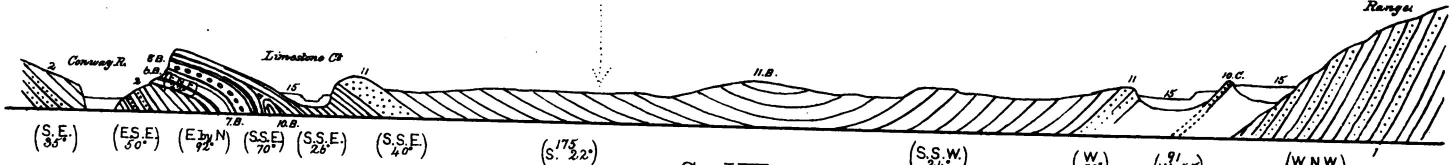


Sec. XI.

Opposite Sections on Conway R.



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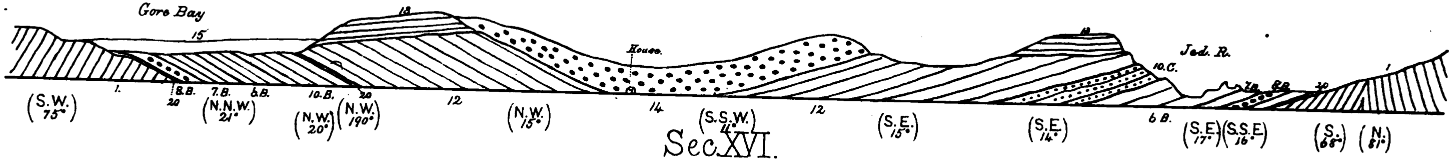

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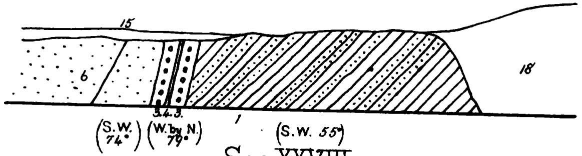

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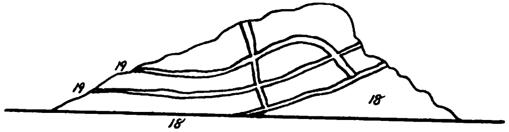

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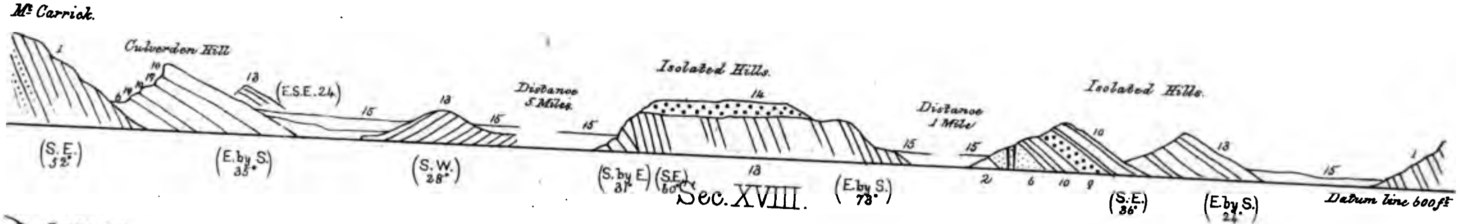

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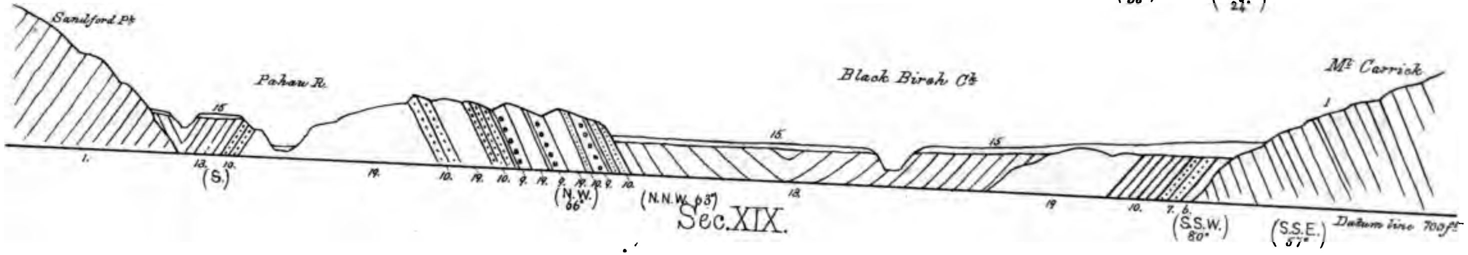

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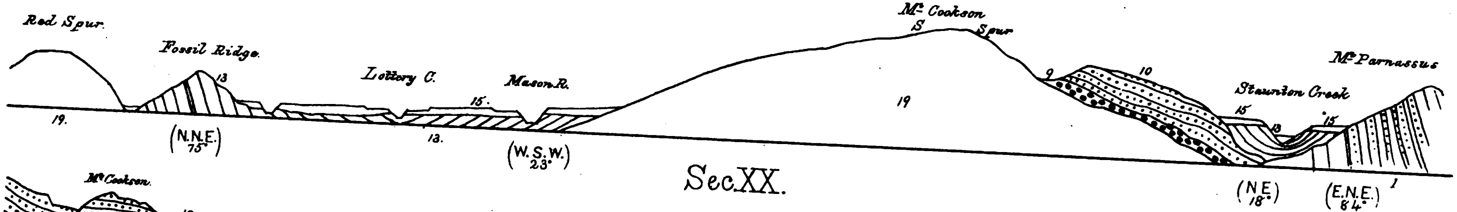

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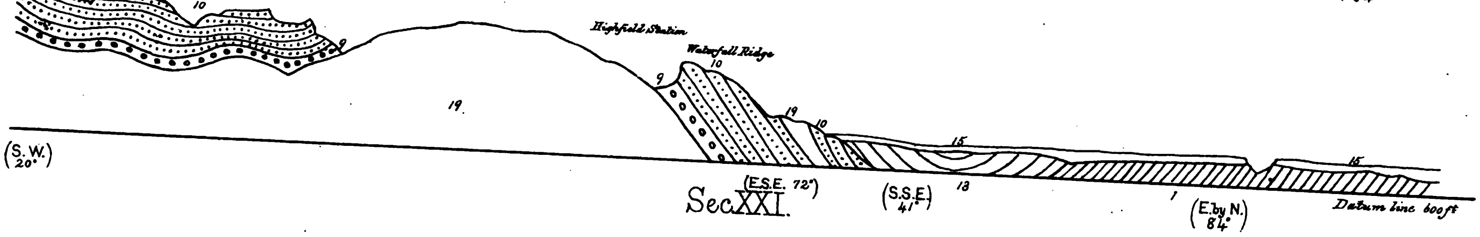
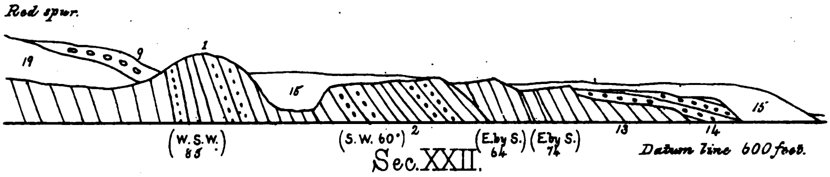


Sec. XXI.



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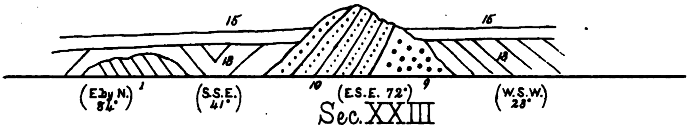

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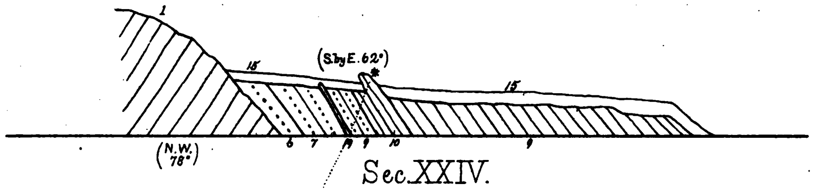
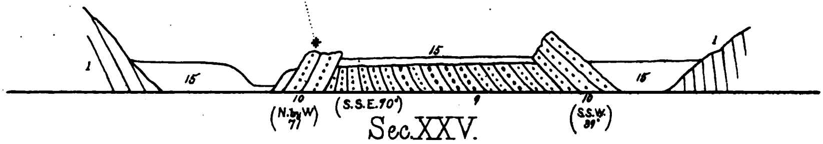
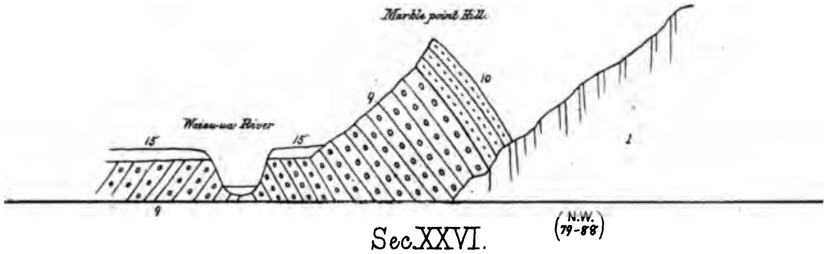


Sec. XXIV.

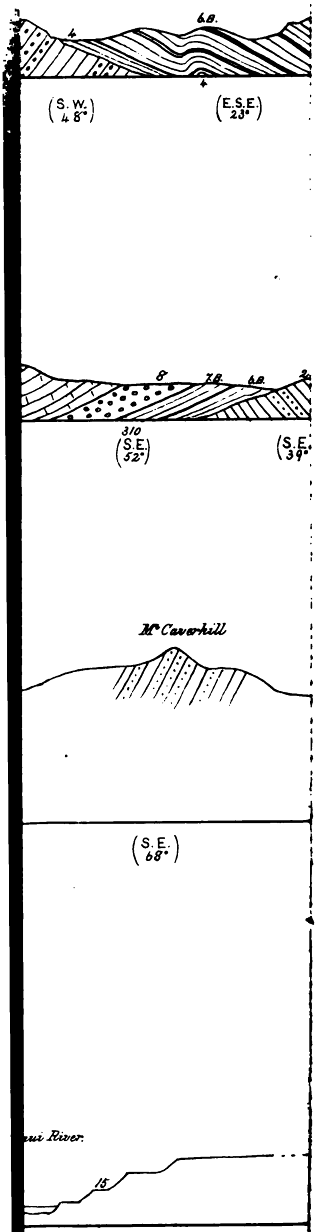
* Opposite points on River.



Sec. XXV.



Sec. XXVI.


4
6B.
4
(S.W. 48°)
(E.S.E. 23°)
8
7B.
6B.
2
310
(S.E. 52°)
(S.E. 39°
Mc Caverhill
(S.E. 68°)
ui River.
15

outhern slopes of summit of Mt. Cookson to opposite junction ottery Creek with Mason River. N. to S. 1,800 feet to h, horizontal and vertical.

Red Spur, Lyndon, to Waiau-ua Plains. N. to S. 1,200 feet inch, horizontal and vertical.

n of Tertiary Beds (Turritella Beds) with Jurassic Beds, in Gates, Mason River. S. to N. 1,000 feet to 1 inch, horizontal vertical.

ı side of Waiau-ua River, opposite to Marble Point. N. to S.) feet to 1 inch, horizontal and vertical.

Point, western side of Waiau-ua River. N. to S. 1,000 feet inch, horizontal and vertical.

Point, Waiau-ua River, from eastern banks of Waiau-ua to rn slopes of Western Hills. E. to W. 1,000 feet to 1 inch, ontal and vertical.

of Mandamus. N. to S. 100 feet to 1 inch, horizontal and cal.

l Creek (Mandamus). W. to E. 1,000 feet to 1 inch, hori-ıl and vertical.

ENCE TO NUMBERS ON THE FOREGOING SECTIONS.

zoic and Lower Mesozoic Sedimentary Rocks.

rmation.

e. Brecciated bottom Bed of Jurassic Beds in Mandamus.

rown Coal.

(Jurassic.)

} Quartzose Sandstones with Fossiliferous Calc Sandstone Bands

} Greensands with Fossiliferous Conglomerate Beds.

ptaria. Sandy Clays with Efflorescence of Sulphur.

a, Fossiliferous, often Calcareous. (Culverden Series, or McCoy.)

nestone. (Culverden series.)

(Amuri Bluff.)

ındstone, Shales, Marls, &c. (Weka Pass series.)

sands.

tones, Marls, and Calc Clays. (Leda Beds.)

ds. (Tertiary.)

ıgle and Sand Beds.

Alluvium.

Marine Sands and Conglomerates.

ıe Beds.

onglomerate of Section XVI.

fossil plants on fractured surfaces. The shales contain a good deal of ferruginous matter, and thin coal partings, but no distinct coal seam was observed.

The lowest beds of this series could not be seen, but half a mile further up the valley, the river flows through a channel cut into green sandstone and slates, which from their mineral character, are probably of *Triassic* age, that strike N. 35° E., and dip at 48° to the east. The mineral resemblance of these rocks to the Lower Otapiri series of Southland, where I obtained Spirifer and other fossils, is exact, but I could find none here. These beds pass into soft shales that strike N.W. by W. Above Washpool Creek the river is confined in a narrow gorge, where it has cut through a dyke of dolerite or augitic basalt, with calcspar in the joints, passing into pitchstone.

This dyke is in contact with the Triassic rocks on the east, but on the west side with the coal formation, which it has completely inverted, so that at first it dips east or towards the dyke. This formation, as exposed in a landslip on the north side of the river above the gorge, consists of a gray quartzose sandstone, derived from the disintegration of quartzose porphyries, and containing thin irregular seams of coaly matter. Under the sandstone, ironstone beds appear, and in that part of the stream opposite Redwood Station, the same ironstone strata are seen to form the floor of the valley, interbedded with coarse quartzose grits, finely laminated shales, and ten well defined, but thin seams of coal, the thickest being only 2 feet 9 inches. The strata are almost vertical, having a steep dip to the W., the strike being N. and S.

As the sandstone and grits interbedded with the coal seams have evidently been derived from the porphyry, we must assume that the dolerite and pitchstone that has disturbed the coal group, belongs to a newer and distinct volcanic series. This is a most important point in determining the structure of the country.

Section No. 1 shows the relation of the rocks as observed at Rockwood.

The coal seams mentioned as exposed in the river opposite the station, are contained in the northern continuation of group *a*, which expands in that direction. The coal is sometimes compact, and workable, but more generally friable. The ironstone is a heavy clay band, very pure, of a fawn brown colour on the fresh fracture, but coated with per-oxide where exposed.* It occurs in nodules and thin beds, and contains fragments of stems and leaves of plants that are not recognizable. By ascending several of the gullies in the range on the N.E., I satisfied myself that the porphyry underlies the coal, and that the coal again lies beneath the heavy beds of sandstone. In the gully behind Rockwood Station, the porphyry has a tabular structure, the joints or cleavage lines dipping into the hill or towards the west at 30° to 50°. It is white, green, and bluish-gray, and recalls the character of the trachyte porphyry of the northern provinces of New Zealand. The porphyry continues right to the highest point of the hills, making a poor light soil. It weathers into very abrupt crags. On the top of the ridge leading to the point where the gorge of the Rakaia cuts the front range, there is a sudden change in the soil to a stiff wet clay. This marks the change from the porphyry to a formation of pitchstone, which decomposes with facility into a clay.

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* This ore has been since analyzed, and found to contain 40·74 per cent. of iron.

In a gully at Windwhistle, I examined a vein of chalcedonic quartz that seems to mark the junction of the two kinds of rock, the porphyry being on the N.E., and the pitchstone on the west. The quartz is jasperoid and chalcedonic with bands of white sub-crystalline quartz. A number of men were hanging about this reef, as gold was stated to have been found in it, but I saw none in the specimens shown to me as auriferous.

On the east side the quartz passes into irregular veins contained in a soft blue clay. The total thickness is about 2 feet. A small quantity of iron pyrites is found in the quartz.

In 1864 I examined the coal strata which are exposed in the cliff on the left hand side of the Rakaia River above the gorge, and the strata exposed were very similar to those below Rockwood, and quite as much disturbed. The section at this place tends also to prove that the porphyrys belong to a much earlier series of volcanic rocks than those which caused the last disturbance, as there are interbedded conglomerates consisting of rolled fragments of no other rock.

The following section, No. 2, was observed on the north side of the river, a few hundred yards below Bryant's coal mine.

(*a.*) Coal seam, the relation of which to the other strata was not made out.
(*b.*) Conglomerate of pebbles of various kinds of rock.
(*c.*) Shale and ironstone.
(*d.*) Conglomerate, composed entirely of pebbles of the quartzose porphyry.
(*e.*) Breccia clay, marking a fault.
(*f.*) Basalt.

(*g.*) Basaltic tufas, containing masses of chalcedonic and amethystine quartz.

(*h.*) Slates.

From the gorge to the Acheron River, in following up the valley of the Rakaia, the surface has been so denuded and enveloped with shingle deposits, that the coal strata, if present, were not distinguished ; but half a mile east of Mr. Oakden's station in the valley of the Acheron River, a thin outlier of the coal bearing deposits is exposed, resting on the slate rocks, and broken through by basaltic dykes. There are three distinct coal seams, the thickest being 4 feet. The whole thickness of the formation is about 50 feet, the upper part passing into thick beds of tufaceous clay and basalt. The coal is remarkable from its being converted into a true anthracite, yet not in any way coked by contact with basalt.

The basalt dykes are very distinctly exposed in the sides of the valley of the Acheron River, which cuts both the slate rock and the coal shales, converting the latter into a hard slaty rock, the cleavage of which is parallel with the wall of the dyke.

Plan and section No. 3 shows the manner in which the coal occurs in the locality ; (*a.*) slates, (*b.*) coal seams interbedded with aluminous shales, (*c.*) basalt and basaltic tufa, (*d.*) dykes of compact basalt, passing into pitchstone. Beyond the main dyke, further up the river, I was informed that the coal again appears, but is of inferior quality.

Turning off from the Rakaia Valley, I followed down the middle branch of the Selwyn, and visited a supposed auriferous quartz reef in the Thirteen Mile Bush, where a party of nine men were at work. They had cut the reef in several places in the bed of the stream, and sunk a shaft for 30 feet alongside of it. The formation is a blue slate and shale, with beds of metamorphic sandstone. The supposed reef is a band of mullock that runs N.N.E., containing kernels of calcite and quartz intermixed. It appears to be a line of fault, but no proper reef has been struck.

The lower part of the valley is cut through the same formation until it widens out on reaching Upton's Flat, where the coal bearing formation again appears on the south side of the river dipping south at 45°. The base of the formation, where it joins the slate, is seen in the first gully below what is termed Copper Cliff, a hill of green tufaceous sandstone. The line of junction rises up the hill towards Mount Misery, on which a coal seam has been found at a considerable altitude. In the gorge of the Wakaepa, which again cuts through the same slates and sandstones as seen at Big Ben, there is a development of greenstone rocks (diabase, etc.) The same peculiar character is exhibited as at the Dun Mountain, a band of limestone marking the western boundary of the greenstone rocks.

On emerging from the gorge, on Knight's Flat the coal strata are again met with, but are here underlaid by a lower part of the series not observed elsewhere in the district, for at the old station there is a greenish-grey sandstone, with *Polypodium Hochstetteri*, a fossil fern, first found at Waikato Heads by Professor v. Hochstetter, and considered to belong to the secondary formation. This sandstone forms a low spur lying parallel with the front of the Mount Misery range. The boundary of the formation is close behind Mr. Hill's station. In a shaft which Mr. Hill had just sunk, about 100 yards from the junction of the formation with the slate, the following strata are passed through :—

Green sand (like Copper Cliff) . . .	10 feet
Black shale	2 „
White quartzose sand with plants . .	2 „
Black shale	10 „
White sand	4 „
Black shale	10 „
White sand	(not bottomed.)

Near the outcrop of the base of this formation on the top of the hill, masses of sandy ironstone and conglomerate of rolled fragments of quartz porphyry, project above the surface, and have also been struck in sinking shallow pits.

These beds strike S.W. across the valley in the direction of the gap in the Rockwood Hills, on the south side of which the coal occurs with a north and south strike, and high dip to the east. On the south side of Hill's Valley, in the steep slope of the hill, nothing could be found cropping out but the porphyry ; so that it is probable that it cuts off the formation as it does at Rockwood, but in the opposite direction. At the north end of Knight's Flat, is Hart's coal mine, on a low isolated spur that projects somewhat into the valley. There are four distinct coal seams exposed at this place in a land slip on the point of the spur, the coal being contained in beds of finely laminated micaceous clay, with carbonaceous markings, and dipping 30° E. The thickest seam is only 2 feet 9 inches. The coal was noted at the time as being black and lustrous where extracted from the third seam, which is being worked by a drive from the south.

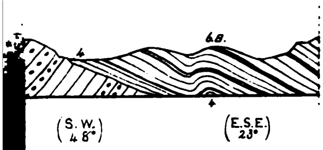
The above beds appear to rest on the fine white sandy clay and white sandstone, as exposed in a drive put into the point of the next spur to the west for the excavation of fire-clay. From the strata dipping eastward, the coal would pass into the hill, were it not for a fault in that direction beyond the dip in the spur, by which we have the sandstone and shales of the lower part of the formation with fragmentary plants, dipping at 12° to the west. The sandstones occasionally pass into sandy conglomerates, and are hard and gritty as a rule. They are well exposed in a low cliff that runs up the slope of the hill obliquely towards the east, reaching an altitude of 400 feet above the flat at which elevation they are seen to rest on the edge of the indurated green sandstones. These older rocks project through the new strata over only a limited area on the top of the hill, and form a wedge-shaped reef that is again enveloped by the sandstones and conglomerates towards the north.

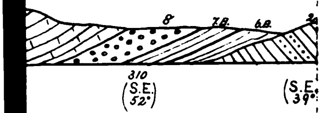
The conglomerates again reach the line of the river at the cliffs above the Church Reserve, marked "Precipice" in the map, where they dip at 45° to the east, and are underlaid by beds of blue shale and sandstone, with carbonaceous markings.

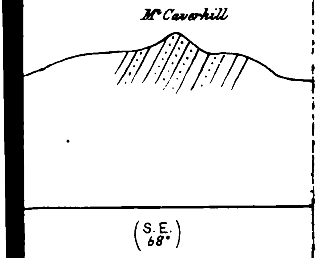
In the brown ironstone at this point, Mr. Lyon got Unio and Pecopteris many years ago. The river appears to pass over a line of fault at this place, for on the opposite side from the above cliff, the ironstone strata are seen to strike at right angles, and to dip to the west. Section No. 4 explains the formation of the district referred to on the north side of the Selwyn, between Hart's coal mine and the Church Reserve. Coal seams have been found at various points on this reserve. A thin irregular seam of hard coal is visible among ferruginous sandstones in a gully at a mile distant in a N.W. direction from a point in the river, where it is crossed by several thick seams of coal, but it is probable that there is no connection between these seams, as the latter are common brown coal, and dip to the south-east. On the south side of the line of fault above referred to, the coal seams are succeeded and overlaid to the east by sandy limestone beds which form a low ridge in the centre of the valley that extends towards Washpool Creek on the Hororata. This limestone contains marine fossils, but in a bad state of preservation; they are chiefly a large black oyster. Dr. Haast, who first found these fossils, considers them to be the same as those occurring with the reptilian remains at the Waipara.

The front range, known as the Harper Hills, is composed of sheets of dolerite, with interbedded tufas, having a S.E. dip, and evidently belong to the period which closed the older tertiary formations.

The Selwyn River cuts through this front range by a wide oblique gap to the N.E., and the longitudinal valley which marks the outcrop of the


4
6.B.
(S.W. 48°)
(E.S.E. 23°)


8
7.B.
6.B.
310
(S.E. 52°)
(S.E. 39°


Mt Caverhill
(S.E. 68°)

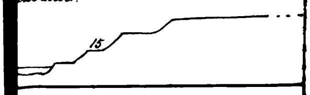

ux River.
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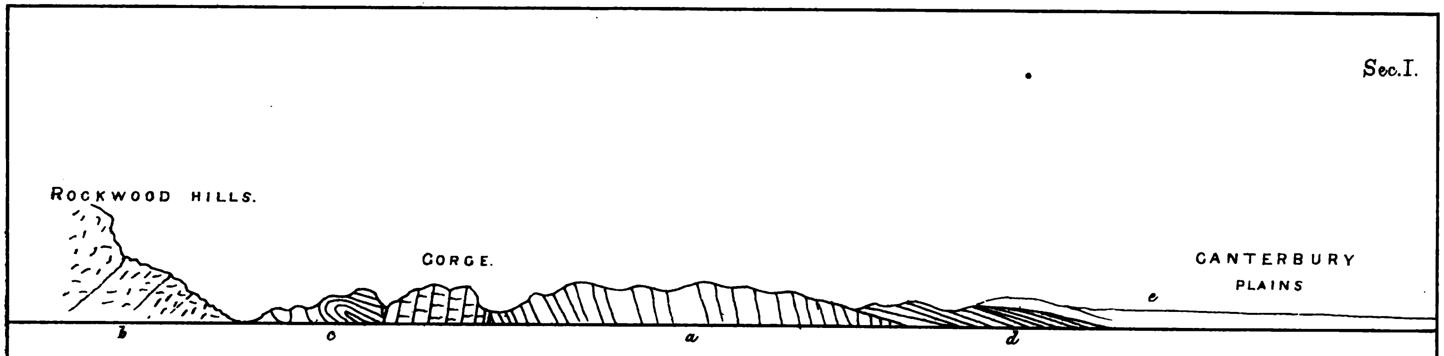
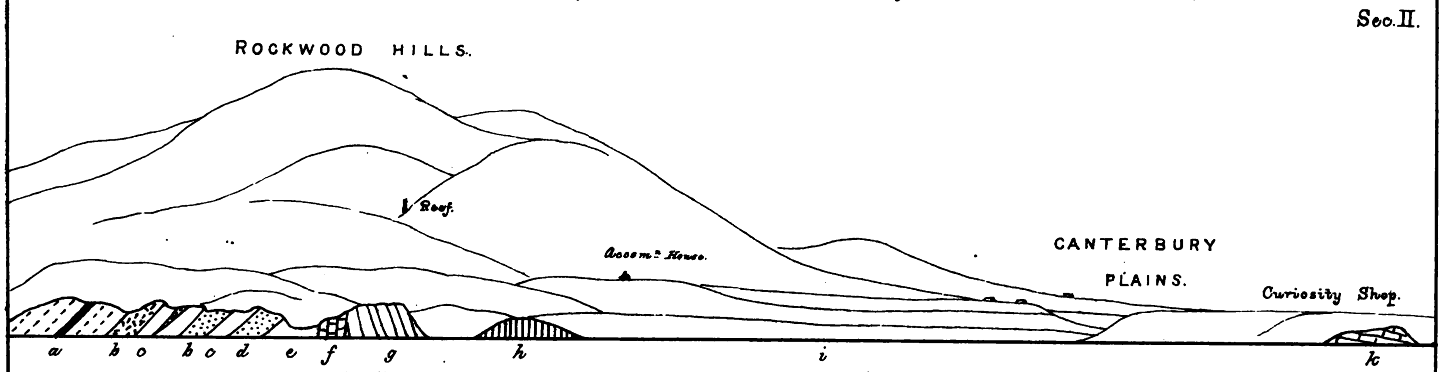
TABLE I.—Abstract of Analyses of Coals from the Malvern Hills.

Date of Analysis.	No.	Locality.	Name of sender.	Approximate Analysis.					Remarks.
				Fixed Carbon.	Hydro-carbon.	Water.	Ash.	Sulphur.	
1864.	...	Kowhai Mine	Dr. Haast ...	61·10	35·40	1·60	1·90	1·80	Colour of ash white, non-caking.
June 19, 1868	224	Kowhai Mine (?)	E. Toomath	73·94	16·60	3·60	5·86	Sulphur included with Hydro-carbon.	
June 24, 1868	228*a*	Rakaiai Gorge	Dr. Haast ...	64·51	21·27	6·76	7·46		Ash reddish-brown, non-caking.
Sept. 22, 1869	607	Kowhai Mine	Dr. Hector...	80·01	10·95	6·50	2·54		Non-caking.
Sept. 22, 1869	608	Hart's Mine	Dr. Hector...	69·62	14·92	2·77	12·69		
Sept. 22, 1869	609	Acheron River	Dr. Hector...	88·91	...	3·17	7·92		
Sept. 29, 1869	624	Kowhai Mine	Mr. Jebson...	66·10	14·10	2·20	17·60		Non-caking, ash light slate colour.
Sept. 29, 1869	...	Big Ben	...	45·00	41·10	12·00	1·90		
Sept. 29, 1869	617	Jebson's Mine	Mr. Jebson...	46·02	26·99	21·66	5·33		Ash yellowish-white, non-caking.
Sept. 29, 1869	618*a*	Jebson's Mine, upper seam	Mr. Jebson...	36·60	31·40	26·20	5·80		
Sept. 29, 1869	618*b*	Jebson's Mine, bottom seam	Mr. Jebson...	36·60	31·70	26·10	5·60		
Sept. 29, 1869	835	Church Reserve	Mr. Jebson...	35·50	36·80	27·10	10·60		Ash white, non-caking.

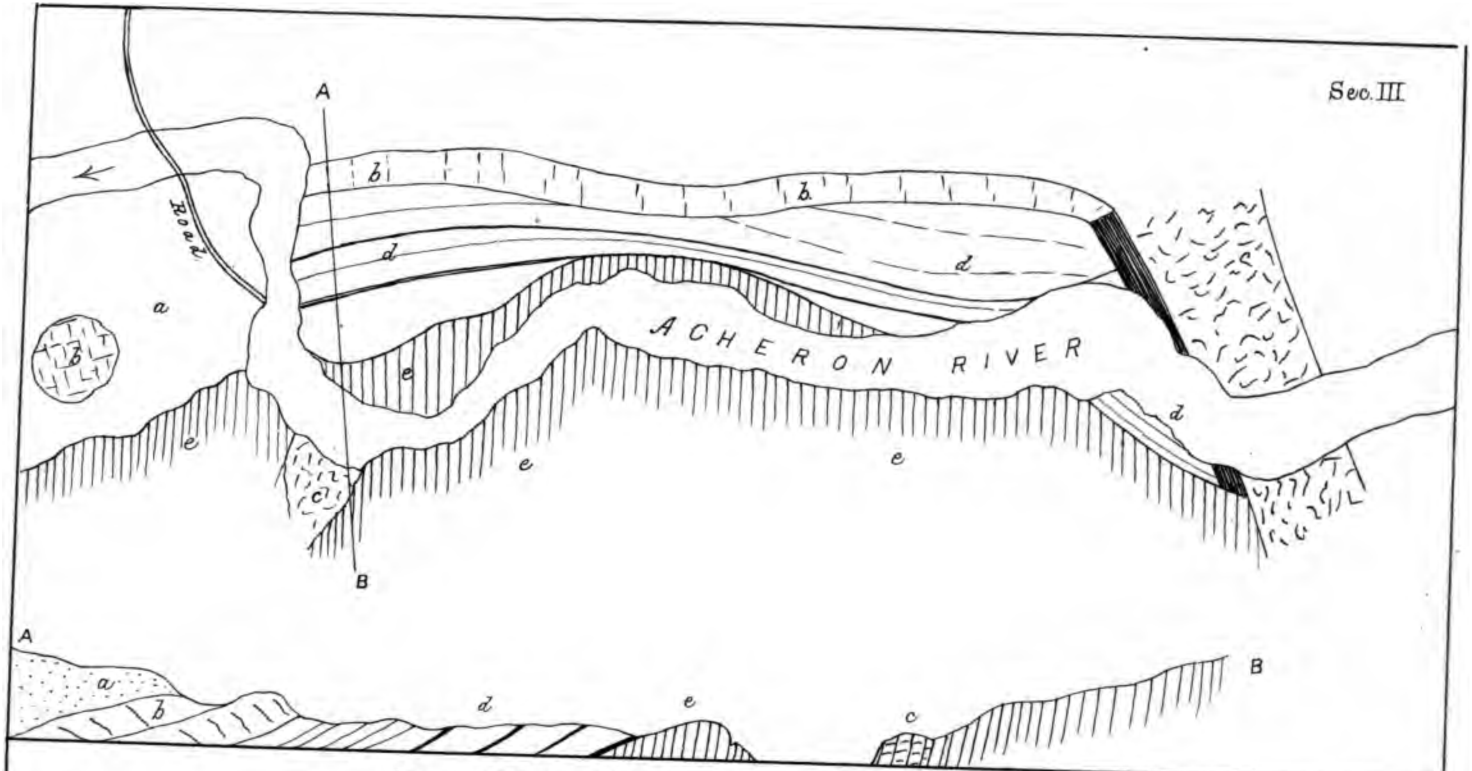


VALLEY OF HORORATA RIVER MALVERN HILLS.

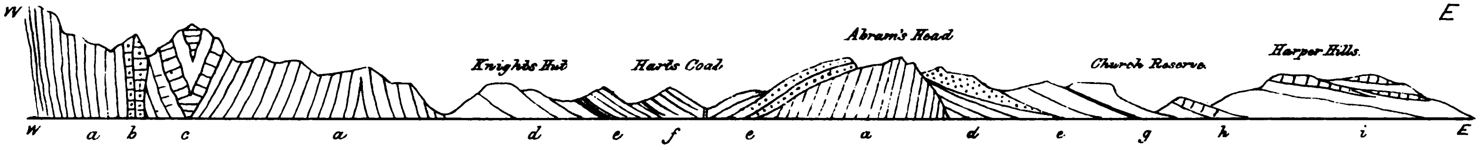
a Slates. b. Trachytic Porphyry. c. Basalt. d. Coal Strata. e. Shingle Plains.



RAKAIA GORGE. NORTH BANK OF RIVER.



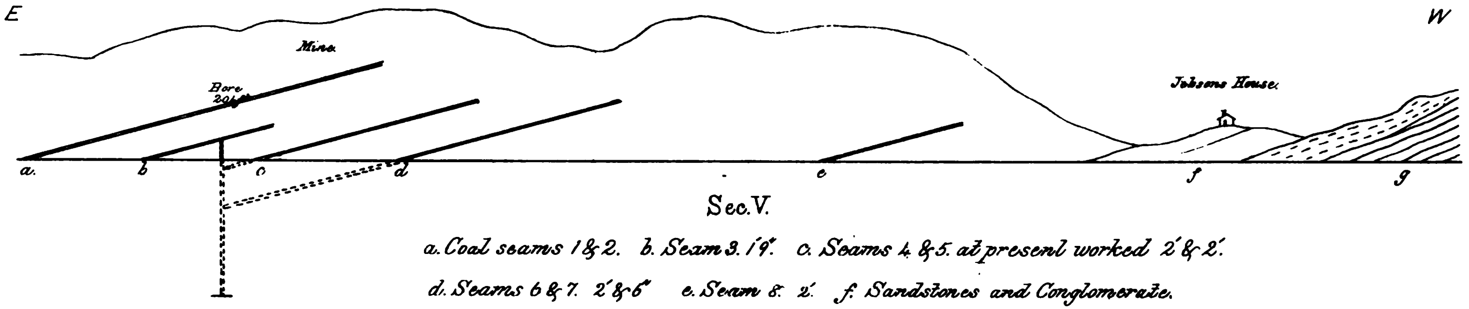
PLAN AND SECTION OF COAL SEAMS
ACHERON RIVER.



Sec. IV.

a. Slates. b Compuct Limestone. c. Greenstones. d. Greensands with Polypodium Hochstetteri e. Ironstone Beds Conglomerates.

f. Shales with Coal seams. g. Brown Coal. h. Calcareous Sands with Ostrea &c i. Dolerite and Tufa Clays.



Sec.V.

a. Coal seams 1 & 2. b. Seam 3. 1′9″. c. Seams 4 & 5. at present worked 2′ & 2′.

d. Seams 6 & 7. 2′ & 6″ e. Seam 8. 2′. f. Sandstones and Conglomerate.

g. Blue Shales. Total thickness of Strata from a. to e. 396 ft.

The coal from Jebson's mine was separately examined, as obtained from the top (618*a*) and bottom (618*b*) of the seam; and also a large block as extracted for the market (617). All the samples had the same general character of a dark homogenous brown pitch coal, the powder being distinctly brown. They did not cake in the least degree, and they leave a light yellowish white ash on being burnt in a draught.

From the roof of the lower coal seam in Jebson's mine, a good fire clay is obtained; with water it forms a strong plastic mass, and in the fiercest heat of the laboratory furnace, it burnt to a fine white brick, without any tendency to vitrify. A special examination showed that it contains only a minute trace of alkalies, so that it ranks as a superior quality of fire clay. With the above coal must be associated a sample obtained by the Hon. Mr. Hall, from the valley between the Wakaepa and the Hororata, near the Church Reserve (No. 835), which is from the same seam as that exposed on the former river at the Church Reserve, and on the latter river below Washpool Creek. This coal is compact, and burns freely for a brown coal containing so high a per-centage of water.

The foregoing are proper brown coals, but all the others mentioned in the table present abnormal characters. The coal from the Big Ben mine (No. 617) has an intermediate composition, being remarkably free from earthy matter, and rich in gas elements, at the same time the quantity of water is moderate.

The composition of the remaining six samples of coal (Nos. 224, 228*a*, 607, 608, 609, 624) shows a decided approach to the type of anthracite coal in the large per-centage of fixed carbon. In the case of the coal from the Acheron River in which this feature is best marked, and the gaseous compounds are wholly wanting, volcanic rocks occur in such a position as to suggest that their influence has effected the composition of the coal seam; but at Hart's mine, where the coal has to some extent this anthracitic character, there are no igneous rocks to account for its being so different in composition from the coal (838) which occurs a mile further down the river.

NOTES ON THE THAMES GOLD FIELDS.

BY E. HEYDELBACH DAVIS, F.C.S., F.G.S.

All numbers refer to the *Catalogue of the Colonial Museum*, 1870.

In the following notes, furnished in accordance with the appended instructions, I have confined myself to bare facts, and abstained from all generalization; the system worked on is that adopted by the officers of the Geological Survey of Great Britain, which I believe is calculated to give the most reliable results.

The first part of the field which I examined was Tararu Creek, from its mouth two miles north of Shortland, to about a mile and a half above the City of London, which claim is the furthest back on the creek.

The distance to this claim is variously estimated at from a mile and a half to three miles above the junction of Tinker's Gully and Tararu Creek, I think that it must be nearer the latter than the former, but as the only available road is the bed of the creek, and that is more than usually rough and tortuous, no reliable estimate either of the distance or direction can be formed; it took, however, three hours hard travelling to return from the highest point reached to the junction of the Alabama Creek, which is known to be two and a half miles from the sea. The creek has now been traversed, and pending the issue of the map by the Provincial Government of Auckland, I can only give unconnected observations on each creek, as I find that I cannot carry some of my lines of observation in their proper directions on the map I had at my disposal.

Section No. I. shows the general formation of the north side of the creek for about half a mile above its mouth, the greenstone breccia (No. 7) then crosses to the south side, where it is seen to be overlaid by a compact diorite sandstone; the breccia appears to be hardened for a foot or two at the junction, but the one passes so gradually into the other, that it is impossible to fix on any actual line of demarkation—it appears to run N. 40° W., dip S.W. 80°;—about twenty-five per cent of the included fragments in the breccia are pieces of a rock identical in every respect with that at the entrance of Tinker's Gully (compare Nos. 7 and 33), other fragments are evidently from an older breccia which has been broken up at the time this was formed, as is proved by the fact of their containing angular fragments themselves (No. 8 is from one of these doubly enclosed pieces). A little to the south of the diorite, sandstone breccia again occurs, but of a totally different character, it being similar in every respect to that found in the Hape Creek (No. 105).

Section II. represents the formation cut in the workings on the Duke's Motto claim. At 7½ fathoms, decomposed porphyritic tufa (No. 3) was cut, next to this came a small leader worth 3 dwts. of gold to the ton, then a bar of very hard splintery porphyritic tufa (No. 5) 40 feet in thickness, and under this a thick bed of white clayey decomposed pyritiferous tufa (No. 4), under this again was a soft mullock in which the drive ends; a shaft was sunk to a depth of 30 feet below the bed of the creek, from which a heading was driven north, striking the leader 30 feet from the shaft and immediately after the hard tufa. About 15 yards south of this the ordinary tufa seems to dip 20° to the east.

Above the junction with Tinker's Gully there are a great number of claims, but all are deserted except the Wild Missouri. The Mississippi drive close to the junction of the Wild Missouri and Russell's mill races, is very interesting, having passed through 60 feet of drift containing large water-worn boulders of diorite sandstone and tufa (some 3 feet in diameter) and loose gravel; the bed rock was a blue greenstone breccia, similar to that found below; the drift formation covers the whole of the northern slope of the ridge;—the reef cut is very poor in gold (No. 11). About one hundred yards further up the stream, Russell's mill race is carried through a rock cutting which exposes from 40 to 50 feet of horizontal section. The bedding appears to be nearly vertical, having a strike N. 40° E., but as in all formations of this sort it is only now and then that it is possible to find a well-defined line of any sort, the direction of the strike does not imply that this particular rock runs in a straight line for any distance; but it may do so. The creek here turns, or rather is turned, rather abruptly by the breccia standing out in the bed of the stream, exposed to the full force of the current, and which is thus kept free from all decomposed particles; this gives it the appearance of being a hard undecomposable stone, quite different from that above, of which it is a part; this particular spot illustrates the whole field, showing as it does how completely the rocks alter their physical character before actually disintegrating. The appearance in the cutting (Section III.) at first sight would lead to the inference that the centre part *c* was a dyke overlaid by tufa more or less decomposed, but a critical examination shows that this is not the case, and that really the parts *a*, *b*, *c*, are all one and the same thing in different stages of decomposition,—this is proved by the fact that wherever the cracks shown in the section occur, there is a lateral repetition of *a*, *b*, *c*, on each side (Nos. 12, 13), the fragments forming the breccia are coarser in structure than the matrix enclosing them, but there are no traces of an older breccia having been broken up while this was forming. One very peculiar feature about the lines of fracture is, that they appear to have given rise to a coarser grained stone for 3 or 4 inches on each side, as if from some cause or another there had been a molicular movement in the rock, thereby allowing the segregation of different minerals.

On the left hand side of the creek at one end of the Wild Missouri water race, the solid hard diorite sandstone makes its appearance, but it is impossible to determine either dip or strike; the La Plata claim, a little below this, and the Try-again, a little above, had white decomposed tufa and solid breccia in the drives, the latter claim cut two leaders, dipping N.W. and running N. 40° E.

At the waterfall by the Star of Polynesia, the channel is cut through the bed rock, which here consists of breccia, identical with the older one in No. 7, the included fragments being considerably softer than the other parts, as they are worn away, leaving the rock full of angular holes; this is the only place where I noticed this feature. After passing the waterfall, the bed of the stream resumes its usual appearance for about half a mile, when it again runs across the beds of greenstone breccia, the channel being cut deep into the solid rock; the porphyry (No. 14) here forms a thin bed about 10 inches thick, and well defined, which crosses the stream, the strike being N. 40° E., dip S.E. 15°. The breccia itself seems to be simply a mass, *i.e.*, having no bedding at all. The thickness is about 150 feet, which is worn into holes here and there, but nowhere deep enough to allow a lodgment of gravel or boulders. Above this the character of the stream changes completely. There are more large boulders of different kinds, but mostly quartz (No. 15) and a red hard rock (No. 16), which is found in pieces varying from 2 to 10 feet in diameter; those boulders are only found for a space of about half a mile, and then suddenly cease. I carefully searched the bed of the creek, but could not find any rock *in sitû* corresponding to them, and therefore conclude that they have come down from the heights above; or else that they are trachyte tufa in some peculiar stage of decomposition, which has desulphurized the pyrites, and subsequently heated the mass to semi-fusion. Several very strong quartz reefs cross the creek at different places, nearly all having a N.E. direction, but none that are of sufficient magnitude to have been the origin of some of the quartz boulders, one of which is more than 30 feet in diameter; this one must have come into its present position by some other agency than that of the present creek, for I traced the stream up both its branches until they were not more than 5 or 6 yards wide, and rock-bound for 100 yards at a time; the largest reef is below this particular spot, and it is only some 12 or 14 feet thick (No. 17). Before reaching the auriferous zone, highly pyritous tufa is found; it gradually becomes more and more decomposed, until, as illustrated by the specimens, it merges into a soft white clay, containing cubes of pyrites (Nos. 18, 19, 20); the process is gradual; the distance between 18 and 20 being perhaps a mile, and many quartz leaders intervening, but none auriferous.

The lowest claim on the Upper Tararu is the Heart and Hand, the first trial is on a well-defined quartz reef (No. 22) running N. 40° E., dip S.E. The Scottish Chief and City of London are the other two claims; all three are working on the same reef (No. 23). Just above these claims the stream divides, one branch running north and the other east, the eastern branch has a very different appearance to the northern one, as it runs in places nearly at right angles to the ledges, and consequently causes numerous waterfalls. Several quartz leaders cross the watercourse, having a general direction of about N. 30° E., the general rock is similar to the pyritous sandstone of Ponga Flat. There is no breccia near that I saw, the rocks are highly pyritiferous, and are undergoing decomposition very quickly, as evidenced by the ferruginous deposits wherever there is slack water, all the little feeders too are nearly choked up with the same, and the water, when still, has a greasy appearance on its surface. This is only observed, as a rule, above the fork (on both branches); but there are one or two cases below, near the City of London claim. One thing about this creek is peculiar, I found no traces of diorite or dolerite, either *in situ* or as boulders, above the Star of Polynesia.

TINKER'S GULLY.

This gully runs from a point on the Tararu Creek, about three-quarters of a mile from the beach, up to the foot of the Look-out Rocks. A little prospecting has been done on the upper or basin part of the slope, but without much encouragement, and all the claims are now idle. The claims on the lower part of the gully are also idle, but they are merely waiting for the tramway to be constructed, as at present there is no track by which they could get their quartz down to the mills.

After leaving the Look-out Rocks, I travelled in a south-westerly direction, until striking the watercourse, and found that all the abandoned claims had been worked in white tufa, mostly argillaceous, and very little of it pyritiferous. From the place where the Moanataiari water-race crosses the gully, to the track leading to Ponga Flat, the formation might aptly be described as a mass of diorite sandstone, with dykes of tufa passing through it, Section IV. A little below the Moanataiari water-race, there is a waterfall of 35 feet or 40 feet in height, over a bed of hard dark diorite sandstone, the perpendicular face of the rock is thickly coated with ferrous oxide, which has also formed a deposit nearly 2 feet thick in the basin at the foot of the fall, above which I did not notice any of this rock. This bed of sandstone extends for 300 feet down the stream, in a direction of S. 70° W., without a break, then there is 150 feet of tufa-breccia, when it again occurs, but this time not nearly so sound. Lower down there is another waterfall similar to the first, but wanting the iron deposit, the diorite, too, is not so sound. Then a thin band of tufa (No. 28) and diorite sandstone again, tufa with pyrites, diorite sandstone, tufa similar to No. 28 (the pyrites here become more marked, No. 32 is from a deserted claim), white tufa, diorite, and just below this is a drive in white tufa, which cuts a strong quartz leader (No. 30). No. 31 is the bed rock at this point, which is about 250 yards above the end of the tramway at the junction with Tararu Creek. At the junction, and a little below the Lady Bird low level, the gully is bounded by a compact light greenstone (No. 33), containing crystals of felspar, hornblende, iron pyrites, and olivine; on the opposite side of the creek is a hump of decomposed stone, similar to No. 3 it appears to be the core of a small spur which comes down behind the main ridge between Tararu Creek and Tinker's Gully.

Opitomoko Creek,

Lies next to the Tararu Creek, on the S.E.; it is divided from Tinker's Gully by a range composed principally of tufa and argillaceous sandstone. Nowhere in the upper part of the range does the compact diorite sandstone make its appearance, until the creek is considerably below the level of Tinker's Gully; the crest of the dividing range is about 600 feet above the junction of Tararu Creek and Tinker's Gully.

The Lady Bird and Hand of Friendship, on the Tinker's Gully side, have a drive 90 feet in length, cutting the celebrated Black Reef (No. 32). This reef, I found, runs nearly north and south, with a dip of 30° west; the texture is variable, sometimes harsh and vesicular, and at others hard and compact quartz, but always black, and containing black mud; the black colour is caused by the presence of sesquioxide of manganese. The yield of gold varies from two to six ounces per ton; the thickness from 15 inches to 11 feet; but the average is about 3 feet. This is one of the strongest lodes on the field, extending through five claims, viz., Lady

Bird, Hand of Friendship, Royal Charter, Conqueror, and City of Dunedin, in each of which it is worked, and shows exactly the same characters, roof and footwall both being a soft white argillaceous tufa, with chlorite.

The Kiery Cross claim, a quarter of a mile to the N.E. of the City of Dunedin, and on the very top of the hill, has a somewhat similar leader, which I consider to be an offshoot from the main reef; it runs N. 50° E., with a westerly dip, the footwall soft white flucan, lying on a white mottled tufa (which I believe to be No. 33 decomposed); the leader is about 4 feet thick. This reef was also cut in the Silver Crown upper drive.

Specimen No. 34, tufaceous sandstone, is from the spoilbank of the Scotchman claim. The stone in the Sunbeam and Sunburst claims is the same.

The Sunbeam has cut a reef of good white quartz running N.E.; the first part of the drive was through sandstone, then 40 feet of blue tufa breccia, and after that the reef. The line of the breccia appears to be N. 50° E.

The Silver Crown claim has three drives, one above the other; the upper and middle ones are not being worked at present. Nos. 35, 36, 37, 38, porphyritic sandstone, tufaceous sandstone, galena, zinc blende, and sulphide of silver and quartz, are from the upper one. A quartz reef near the entrance has a strike of N. 40° E., dipping 70° W. Not having a light, I could not get to the end, as I had reason to believe that there were some winzes in the drive. The two lower drives are very wet in places, and when that is the case the rock is divided into angular pieces; the middle level, in particular, tapped a large quantity of water, which ran a considerable stream for about a fortnight, and then ceased, the lower level has passed through the same bar of breccia that the Sunbeam did.

Diorite sandstone appears a little below the Sunbeam, say 80 feet vertical. On the top of the spur between Opitomoko and Shellback Creeks, there are no claims, and the only rock found was the same rotten dead-stone that is found in the Odd Fellows, and the bottom of the Kuranui shaft (No. 47).

WISEMAN'S GULLY,

Lies next to the Opitomoko Creek, on the S.E. side, and is really the main continuation of the Shellback or Pukihinau, the other branches of the creek run into the range which divides it from the Opitomoko, and present little or no interest, very few claims having been worked on the spur, and none of those that have been taken up are now being prosecuted; they are mostly in sandstone, which is very slightly impregnated with iron pyrites.

The surface soil of Wiseman's Gully is a very stiff red clay, which extends in an unbroken sheet from Ponga Flat to below Clarkson's Battery. This clay occurs in many other places, but nowhere else does it cover so large an area.

Coming down towards the beach, the first claim that is being worked is the John O'Groat, No. 1. They have driven into the hill in the same sandstone that was found in the Silver Crown claim (No. 35), and after cutting a reef, have sunk a shaft which has struck diorite sandstone (No. 42), and when I was there, there was no means of telling which way it was running.

John O'Groat, No. 2, passed through two bars* in their drive, one over 100 feet thick, and the other one, 27 feet. The other part of the drive is in a sandstone similar to No. 34; no leader has yet been struck in this claim. The direction of the diorite is N.E., dip S.E., but this and all other directions and dips of diorites, dolerites, etc., which I give, must always be understood to apply to the surface actually exposed to view, as I consider it quite impossible to give them their true bearings, for reasons which will be evident in the course of my remarks; I have therefore contented myself with giving the localities and *apparent* bearings.

The Pride of Erin leader is supposed to lie under these two bars, but they have never got through the first. See Section V. In the proximity of the diorite sandstone there is some white tufaceous sandstone.

The lower part of the Shellback Creek is quite barren, the *foundation* being a hard trachyte sandstone, almost entirely void of pyrites, and the quartz reefs, although strong, quite barren, and the quartz hard, compact, and very white, the surface soil is different to that in Wiseman's Gully. No. 131, sandstone, is from the beach opposite the creek.

MOANATAIARI CREEK.

This creek has hitherto, from its central position, been the most important in the field, for although some of the claims in the Kuranui have given more startling returns, the Moanataiari is the most steady in its yield of payable quartz; one reason is, it extends far enough back to cut most of the auriferous zones, viz., the Golden Crown zone, the Kuranui zone, and the Lady Bird zone. I will here remark that these zones have nothing to do with the *direction* of the *reefs*, only with their auriferous character.

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* Bar is a North Country miner's term, and is usually applied to any stone different to the ordinary "country," and in which no mineral is ever expected.

The Caledonian Company, while sinking with the intention of cutting the Golden Crown reef, met with a mass of diorite sandstone (No. 50) of considerable thickness, which came into the shaft from the north or north-east, but never entirely cut off the tufa on the side next the Golden Crown claim; it came in as shown in Section VI., and then retreated, but afterwards again rapidly swelled out and again diminished, till it finally disappeared; the total thickness was over 40 feet, the shaft then came into the same stone as the roof of the Golden Crown (No. 52), and thus gives every encouragement to the hope that they will meet with no more difficulty;* it will be interesting to watch if this diorite again comes into the workings.

The site for No. 2 Platform, Section VII., is cut in a patch of hard blue diorite sandstone (No. 53), which extends up, and across the creek a little north of this, and on the other side of the gully is a bed of pinkish-white and green stone (No. 55), which I consider to be only a decomposed variety of No. 53. This specimen shows a tabular structure, breaking with three faces of a regular rhombohedron.

Specimen No. 56, quartz and pyrites, is from the spoilbank of the Point Russell claim.

No. 8 Platform is in a cutting of thoroughly decomposed dolerite. Hard compact diorite sandstone occurs again on the left side of the creek opposite No. 9 Platform.

No. 11 Platform stands in a cutting in a decomposed dolerite; No. 57 is a specimen of the undecomposed centres.

At the very top of the creek is the claim called the Bendigo Independent, the first part of the level was in white tufa mudstone (No. 58), it then cut diorite sandstone, with calcite veins and pyrites (No. 59). The claim is not being worked at present, but on the bank there was a good deal of pyritous quartz; No. 55 also represents the nature of a part of the stone taken out of this drive.

WAIOTAHI CREEK,

Is separated from the Moanataiari by a spur of considerable altitude, on which some really good claims are situated, the Caledonian, Morning

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* They have since struck the leader.

Star, and Dauntless on the Moanataiari side, the Manakau and Cure on the Waiotahi side, with the Golden Crown at the end; these claims are all working for the Golden Crown leader. The spur is composed chiefly of tufa sandstone, possibly the core or centre is diorite sandstone, but this remains to be proved. The Waiotahi Company's shaft is almost entirely in the tufa, the roof and footwall of the leader both being the same, viz., composed of tufa containing chlorite and a little pyrites; it is stained red-brown at the joints, but this is merely owing to the percolation of water decomposing the pyrites, the leader runs about N.E., and dips 2 feet per fathom, north; the quartz and pyrites, however, disappear so very gradually, that it is difficult to make out where the reef ends and the "country" begins. In the United Company's shaft, on the other side of the creek, three well-defined leaders were cut at a depth of 100 feet; one is about 3 feet, and the other two 9 inches thick, the quartz is very hard and unkindly looking, breaking with a sharp splintery fracture; these leaders run east and west, and dip north; they were also found in a cross-cut at 50 feet, where they are not so well-defined quartz is more promising in appearance; Nos. 67 and 68 are from the roof and footwall respectively. In this drive the air is very bad.

Specimen 69 is from a drive about 100 yards further up the creek. The stone, when first brought out, is comparatively firm, but presently falls away into a heap of sand; the specimen is in an intermediate stage; this is in the spur next the Karaka Creek. Specimen 70 is from a shaft close by the Bachelors, No. 1, claim.

The dyke mentioned by Captain Hutton as crossing the creek at Johnson's Battery, is represented, I believe, by Specimen 71, taken 70 feet from the entrance of the drive, which goes into the Ballymore claim. The battery now belongs to the Golden Age Company, and I believe that considerable alterations have been made since Captain Hutton visited the place, as I could not discover any undecomposed rock in the bed of the creek, but at the back of the mill, where a cutting has been made, the same rock may be traced in a thoroughly rotten state. A man who had worked in the place, told me that there were two dykes, one dipping towards the Karaka, and one towards the Moanataiari; the one now under consideration runs N. 70° E., and dips S.E. The remark I have before made in reference to these bearings, applies in this case also. The only plan that is at all satisfactory, is to carefully mark every place where these rocks occur, and afterwards to deduce a system.

The other dyke, diorite sandstone, is cut in the New Moon drive, and is represented by Specimen 73. The claim is now protected, so I could not get underground, but judging from the rubbish heap, the drive must be of considerable length. This dyke is said to run north and south, with a westerly dip; the intersection of the two has never yet been found.

Specimen 74, trachyte tufa sandstone, is from the Half Moon Extended; the claim is now idle; I could not find any sound diorite sandstone on the tip.

Specimen 75 represents a brecciated quartz reef from the Queen claim; I do not think that any gold was ever found in it.

Specimens marked 80, 81, 82, are from a true dolerite dyke, which appears near the Freeman's Bay battery, on the south side of the creek. This dyke appears to run N. 30° E., this is inferred principally on account of the appearance of the country, I did not find it again in that direction. I was told that it had been met with in the Republic claim on the top of the hill towards the Alabama Creek, but I think it is extremely doubtful. On the opposite side of the creek is a pink and white laterite, corresponding to the laterite in Kiko-waka-reru Bay, at Coromandel, and this, I believe is the only place where the districts at all correspond.

Specimen 83, sandstone, is from a cutting just above Weston's battery.

KARAKA CREEK.

The aspect of this creek is quite different from any of those previously mentioned, especially at its mouth, the first claim on the left or north side having had to drive through a bed of trachyte breccia, before getting into the tufaceous sandstone which carried the reef; this breccia, represented by No. 84, contains fragments of slate, but no traces of other sedimentary rocks. A little further up, and at the lower end of the first bridge, is the Pretty Jane claim; there are three leaders as shown in Section VIII.; the centre one is vertical or nearly so, heading N.° 10 E., the other two dip towards it; all three have had short drives on them, and have been found to contain gold, they are in a mixture of breccia and tufa sandstone; there is a centre or core of diorite sandstone close by on the west side. At the head of the mill race the breccia again makes its appearance; close to this place there is a drive put in for upwards of 70 feet in a hard grey rock, which dips into the hill N.W. Just below the dyke marked by Captain Hutton at the Hokianga machine, the creek makes a turn, as shown in Diagram IX., the tramway being carried round the bend on a viaduct. The drive to the S.W. never touched the dolerite.

A little further up is a bed of boulders, and then calcareous diorite sandstone, similar to No. 86; opposite to the Democrat battery, about one hundred yards beyond, there is another boulder bed, Section X., which also represents several other sections that occur in the creek. The boulders are compact hard dolerite, embedded in a tenacious red clay.

A little above this again, is the Union-jack claim; No. 89, slightly brecciated tufa, is from the drive, the *white tufa sandstone gradually merging into the sound dark grey diorite sandstone.* Specimen 90, decomposed dolerite, is from the cutting next above, the clay being taken out from between the joints of the sounder part of the stone.

Before coming to the Alabama Creek there is a patch of the ordinary blue tufa.

About 250 yards up the Alabama Creek there is an outcrop of diorite sandstone, apparently dipping W., strike N. 10° E.; it is very similar to that at the bottom of Hape Creek.

In the first cutting above the next bridge, diorite sandstone (No. 86) makes its appearance; above the third bridge from the junction we again have decomposing diorite running N. 10° E., dip W., with blue centres, here and there followed by a broad belt of rubble. Close to the end of the tramway there is a hard dark blue dolerite, weathering grey with black crystals, and then passing into a brown colour (Specimen 91). See Section XI.

Lucky Hit Branch.—One hundred yards above the fork, there is a patch of sandstone (Specimen 92), which is very similar to that obtained near Weston's battery (No. 83); it crops out by the side of the track for a few yards.

All the mines in this locality are now idle, why, I could not make out. The quartz appears to be of a highly crystalline nature, and frequently incrusted with iron pyrites; calcite and selenite are also present in the reefs. The bed rock is the ordinary tufa of the Moanataiari Creek.

Specimen 27 is from the very top of the Look-out Rocks. I believe that this rock strikes N. 10° E., but this is only from the appearance of the country in that direction; the structure is a highly pyritous crystalline sandstone.

HAPE CREEK.

The hill on the east side of this creek appears to be principally composed of diorite sandstone, upon which a bed of trachyte breccia rests, the course of the stream being more or less determined by the line of junction (see Section XII.); the breccia appears in several places on the creek, sometimes on one side only and sometimes on both, but the watercourse is never far from the junction. In the Hape Consolidated claim, at the mouth of the creek, the drive was put into the hill on the east side, and passed through, first, a sort of rubble having only small centres of sound stone, these gradually got larger until the stone was nearly solid. The drive in the Morning Sun claim, a little further up and on the other side of the creek, seemed to have passed through, first, soil and loose stones, then a grey stone very prone to decompose and fall to powder or sand, then a harder variety, and finally, a compact diorite sandstone in which the level ends; the length of drive is about 100 feet. Specimen 99 represents these stones.

About a quarter of a mile up the creek a fine-grained sandstone (No. 101) appears, which lies next to the breccia; it forms the core of two or three spurs, and always presents a smooth rounded top, which is covered by a foot or two of stony brown earth.

The breccia does not present quite the same appearance all the way up the creek, Specimen 103, however, shows its average composition; the first place in which it appears is a little above the sandstone (No. 101) where a piece of included stone here and there attracts attention; it gradually becomes more and more charged with foreign matter till it presents the appearance shown by the specimen.

Specimen 103, trachyte breccia, and 104, green trachyte, are from a cutting immediately below the Black Eagle claim, where the two may be seen as shown in Section XII., neither being in the slightest degree altered by the presence of the other.

The diorite sandstone appears again a little further up, and about 200 yards beyond, breccia (No. 108) in contact with it.

TARARU POINT.

Just round the Point (from Shortland) there is a bed of slate (No. 26) which runs N. 40° W., and dips 25° W.; the bed is only a few feet thick; the cleavage is very imperfect, and it is intersected by small quartz veins in all directions; it appears to dip under the claystone (No. 128), which forms the Point itself; this claystone, where it lies on the slate, partakes of a thoroughly slaty character, in fact the division between the two cannot clearly be discerned, even the different colours shading off and blending. The claystone itself is cut through by a broad band of pyritous quartz sandstone (No. 129) which splits the Point proper into two projections. (See Sections XIII. and XIV.) The course of this latter stone is marked by a depression in the hill, where it has worn away leaving the harder claystone standing.

Lying on the claystone is a coarse grained breccia (No. 130), containing small pieces of slate; on this again is a bed of sandstone, similar to No. 129, containing many veins of solid quartz, and some bands, about 2 inches wide and very regular, of massive felspar. A little to the south of Waihohanga Creek the stone is slightly altered, appearing to be in thin laminæ; it also alters its outward colour, and dips S.W.; it gradually passes into No. 130 again; next to this is a bed of coarse breccia, containing large pieces of slate on the north side, which it gradually looses as it approaches the alluvial flat at the mouth of Tararu Creek.

General Remarks.

The presence of gold in the reefs in payable quantities is not marked by any distinct features, the manager of each claim having a different reason for expecting a reef to turn out well or the contrary.

1st. In Hunt's and the Kuranui mines, gold is expected when the reef becomes rich in pyrites and the quartz more or less dislocated.

2nd. In the Long Drive, gold is expected when the reef besides having the ordinary grey flucan, contains patches of a shiny black greasy compound, which stains the hands a permanent black (No. 118).

3rd. In the Golden Crown, it is considered a good sign when the reef contains pyrites, is a dull grey colour, and is more or less mullocky.

4th. Manukau and Cure, the same.

5th. Waiotahi,—quartz not too hard and compact, grey flucan and pyrites.

6th. Dauntless and Sink to Rise,—reef slightly decomposed, with small leaders of quartz running through it, the whole being a dirty white.

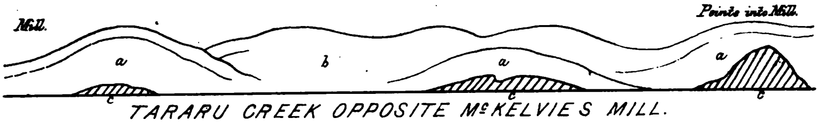
The managers are all agreed on one point, viz., that they cannot, *by the experience* they have had on this field, give a satisfactory reason for expecting gold in the reefs, and also that they cannot tell yet if any change has taken place below the water level, as they have not done much work at that depth.

My own personal observations have led me to the following conclusions:

1st. Pyrites in the matrix of the lodes is a *sine qua non.*

2nd. The hanging wall or roof need not of necessity carry pyrites, but rather the richness of the reef is increased by the diminution of pyrites in the roof, provided the footwall is rich in them.

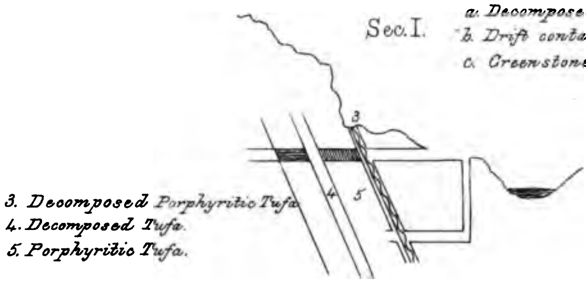
3rd. Leaders joining the reef on the hanging wall probably increase the yield of gold for a time; leaders from the footwall, seldom.



TARARU CREEK OPPOSITE McKELVIE'S MILL.

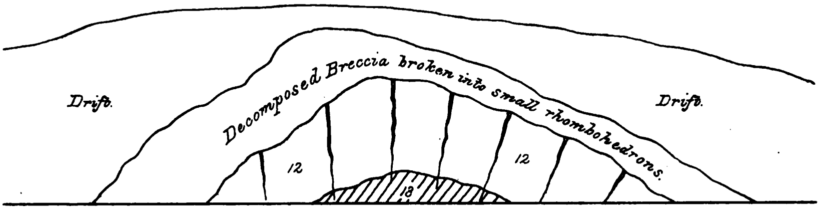
Sec. I.

a. Decomposed Breccia.
b. Drift containing Diorite Boulders.
c. Greenstone Breccia. (7.)



THROUGH THE DUKES MOTTO. TARARU CREEK.

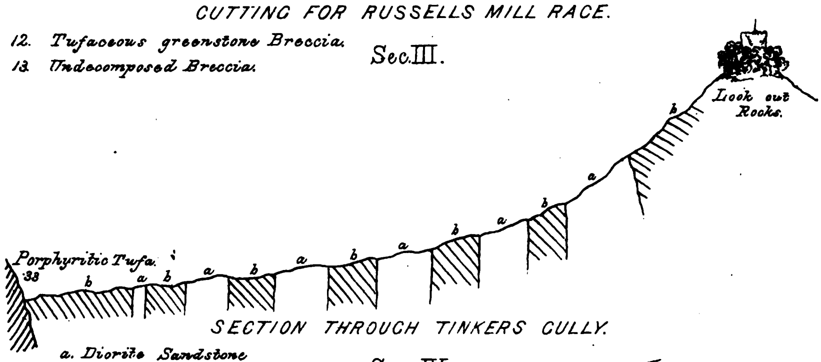
Sec. II.



CUTTING FOR RUSSELLS MILL RACE.

12. Tufaceous greenstone Breccia.
13. Undecomposed Breccia.

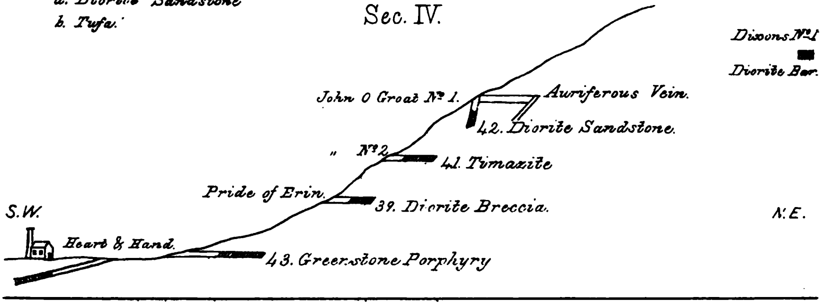
Sec. III.



SECTION THROUGH TINKERS GULLY.

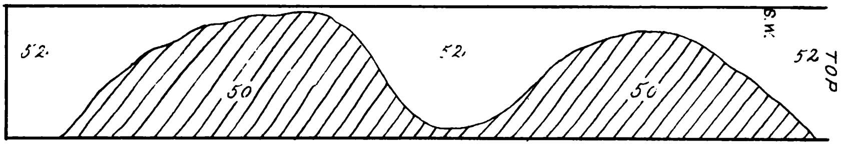
a. Diorite Sandstone.
b. Tufa.

Sec. IV.



SECTION THROUGH WISEMANS' GULLY.

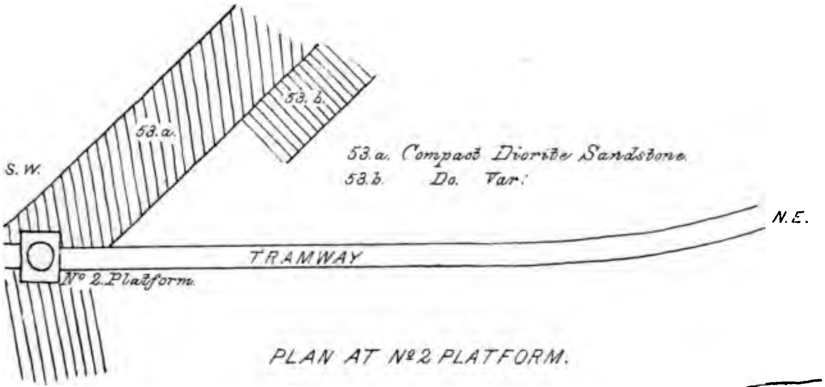
Sec. V.



THROUGH CALEDONIAN SHAFT.

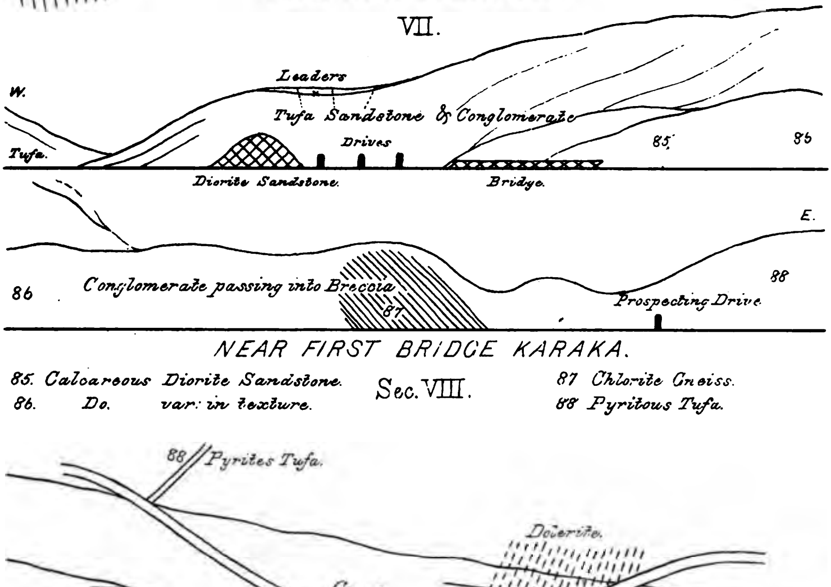
52. *Soft Tufa Mudstone*   50 *Compact Diorite Sandstone*

Sec. VI.



PLAN AT No 2 PLATFORM.

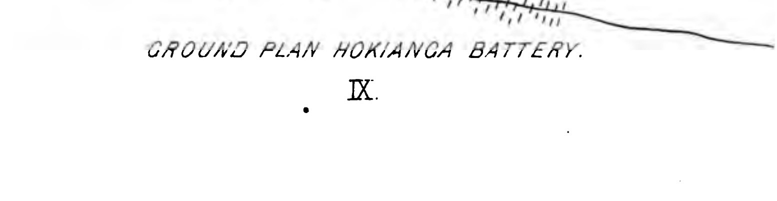
VII.



NEAR FIRST BRIDGE KARAKA.

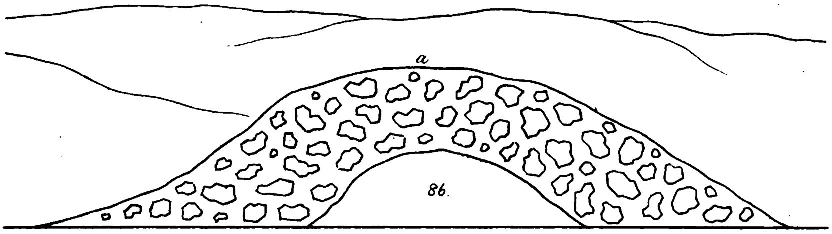
85. *Calcareous Diorite Sandstone.*   87 *Chlorite Gneiss.*
86. *Do. var: in texture.*   88 *Pyritous Tufa.*

Sec. VIII.



GROUND PLAN HOKIANGA BATTERY.

IX.

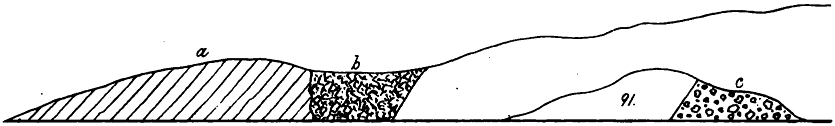


VERTICAL SECTION ABOVE ALABAMA CREEK.

Sec. X

a. Dolerite Boulders.

86. Calcareous Diorite Sandstone.



100 Y^{ds} BELOW LUCKY HIT

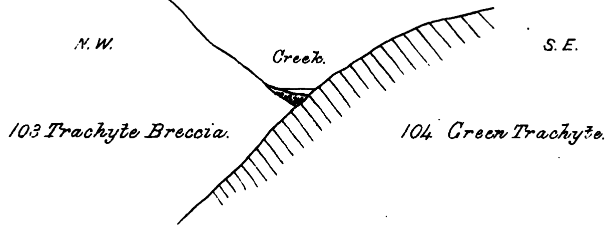
Sec. XI.

a. Decomposed Diorite.

b. Rubble.

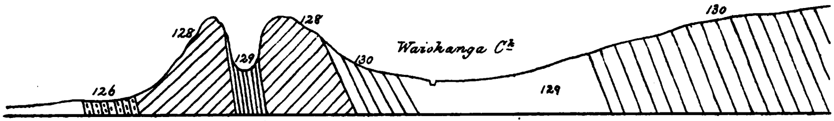
c. White agglomerate.

91. Dolerite.



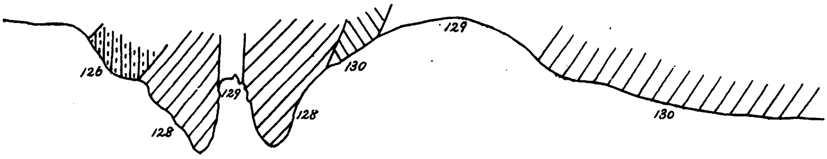
HAPE CREEK NEAR BLACK EAGLE

Sec. XII.



VERTICAL SECTION TARARU POINT

Sec. XIII.



SKETCH OF COAST LINE TARARU POINT.

XIV.

126. Slate

128. Indurated Claystone

129. Pyritous quartz Sandstone.

130. Tufa containing splinters of Slate

4th. The direction of the leaders in the tufa sandstone has nothing whatever to do with the auriferous quality, provided the leader runs more or less parallel with the direction of the diorite sandstone.

5th. The free gold will decrease with the depth of the workings, but, if the land has been elevated at some previous time for a considerable period above its present level, and consequently the water level lower, the gold will probably continue down to that depth, but not beyond it. The claims near the beach are already beginning to find the reefs harder, the pyrites more solid, and the yield of gold less.

6th. The leaders nearly all being formed by segregation, are particularly amenable to atmospheric agency in liberating the gold.

MEMORANDUM OF INSTRUCTIONS FOR E. H. DAVIS.

"I wish your attention to be specially directed to the collection of a series of specimens illustrative of *all* the different varieties of rock found in the mineral ground; also specimens of the walls and lodes in the principal claims for the purpose of comparison; also collect six sets of small specimens of the best marked varieties of rock (about twenty kinds) for exchanging with other museums. The former specimens are to be 4 × 3 inches and 1½ inches thick, the smaller specimens are to be 3 × 1½ inches, and 1 inch thick. In the course of collecting the specimens, make full notes of the mineral characters and geological relations of the rocks, taking Captain Hutton's report as a basis, adding to or altering his descriptions as you find necessary. At the date of his examination the field was very imperfectly opened out as compared with the present facilities for observation, so that his description of the claims and lodes will require modification. The work here sketched out will only require you to visit the Thames, Tapu Creek, and Coromandel, and you need never be out of reach of hotel accommodation, it will employ you about three weeks, and should give you an accurate knowledge of the leading features of the district, and enable you to recognize the same formations in other places, and so extend the geological survey of the district beyond the present bounds of the gold fields.

"You must be on your guard against being misled in the discrimination of the various rocks by their proneness to decompose and alter their natural characters.

"In all your examinations keep in view the following important questions:—

"1. What are the essential constants to the presence of gold in the lodes?

"2. Have the lodes any definite mineral characters associated with their direction and underlay?

"3. Do the lodes, from *experience* up to the present time, alter in character as they get deeper or further from the surface?

"4. Has the relative position of the water level in the rock any effect on the mineral characters of the lodes?

"Report the opinion you form on these points to me, along with your descriptive notes, but keep the two branches of the subject quite separate.

"I wish you also to make any notes that occur to you as to the arrangements for milling the ore, and the probable causes of the reported loss of gold.

"James Hector.

"Auckland, 16th April, 1870."

NOTES ON THE PROCESSES IN USE IN THE THAMES MINING DISTRICT, FOR THE EXTRACTION OF GOLD FROM THE MATRIX.

BY W. SKEY, ANALYST.

August, 1870.

In the course of enquiries relative to the mining prospects of the above district, it was found that great difference of opinion prevailed as to the actual amount of gold that escapes with the tailings from the mills, and that this and several collateral questions could only be determined by experiment. For the purpose of making the required analyses, a small laboratory was erected at Grahamstown, where I commenced the investigation in June last. The points to which my attention was specially directed were as follows:—

1. The actual loss of gold in the course of the extraction of the metal from the ore at the different mills.

2. The cause of this loss, and how far it can be remedied.

3. The manner of combination of the gold in different forms of matrix.

4. The effect of the use of sea water, and water pumped from the mines, upon the machinery employed.

1. Loss in Milling.

The loss of gold in the tailings from the mills I thought best to divide into that portion which a more thorough amalgamation would readily catch, and that which could only be extracted by assay.

So much depends upon the manner in which the tailings are sampled, that it is proper to state first with what precautions the selection was made.

MODE OF SAMPLING.

All the samples of tailings examined, or here reported on, were with two or three exceptions, taken under my immediate personal superintendence. Only two were taken from the settling pits, as tailings so deposited would be more than usually concentrated, and so vitiate the results of their analysis.

The rest of the samples were collected either from the larger heaps of tailings which had accumulated in the yards round the various batteries, or else directly from the shoots discharging these, while the batteries were at work.

In those cases where the samples were collected from the heap, each heap was sampled in twenty or thirty different places, as nearly uniform as possible, on all the exposed sides, 5 or 6 inches below the surface.

Where taken as issuing from the tailing shoot of the battery, they were collected in the following manner:—a well cleaned enamelled bucket was placed under the shoot, just long enough to get filled, or nearly so, the contents were then allowed to settle for two minutes, when the water, and suspended matter, was gently poured off, and the residue secured. This process was repeated until enough had been obtained.

When the stuff was crushed fine, and a large head of water used, sampling from the shoot was a very tedious operation, sometimes occupying for a single sample, two or three hours. The value of the after results, however, for such cases, will of course be correspondingly enhanced, since such samples more correctly represent the average of what passes from the batteries day by day, than samples which are hastily taken from the heaps.

All samples were well mixed and dried before examination. The results given, therefore, refer to the respective samples when air-dried.

As regards the choice of sampling from the heap or from the shoot, perhaps the latter is best, as it admits of the more accurate determination of the actual loss of gold upon the stuff as it goes into the stampers, since we can allow with more certainty for the proportion of fine substances carried away in suspension by the water employed.

MODE OF DETERMINING THE YIELD OF GOLD AFFORDED BY RE-AMALGAMATION OF TAILINGS.

For this a hand burdan was used similar in shape and construction to the ordinary ones, and fixed at about the usual inclination.

The rate of delivery of the tailings to the burdan, and also the flow of water employed was made as uniform as possible in every case.

The following are the more important particulars relating to this process :—

Weight of sample . .	2 to 4 lbs.
Speed of delivery . .	1½ lbs. per hour.
Head of water . . .	4 gallons per hour.
Weight of mercury used .	1 oz. per lb. of tailings.

No chemical agent was used to assist in amalgamation by the burdan.

It was found necessary to retort off the whole of the quicksilver from the several amalgams obtained, and not to use leather at all, otherwise the loss of gold which would have ensued must have seriously affected the correctness of the returns.

Where returns were either very small or notably large, and also in several other cases, their correctness was verified by repeated experiment.

The results obtained by the above process are stated in the fourth column of the annexed table.

In a few cases the tailings from this re-amalgamation were collected and weighed, and put back through the burdan and ground up with a further supply of mercury, in the same way as before, when it was found that stuff yielding to the burdan gold at the rate of 2 dwt. 10 grs. per ton, yielded to this second process not more than 11 grs. per ton, calculating upon the normal quantity taken. The weight of tailings remaining in the settling-box for the second amalgamation being 1½ lbs. out of 4 lbs.

In the fifth column of the table is stated the results of amalgamating a portion of some of these samples in a paste after re-crushing them; while in the sixth column is stated the results of re-amalgamation after roasting the samples.

TABLE of RESULTS obtained by the ANALYSIS for GOLD of Tailings from various Batteries, situated in the THAMES GOLD FIELD DISTRICT.

No. in Lab. Book.	Name of Battery whence taken.	Name of Claim.	Rate of yield per ton.				Actual yield of original stuff at Mills.	How taken.	Character of Tailings, with General Remarks.
			By burdan.	By Mortar.	After Roastng	Assay yield.			
			oz. dwt. gr.	dwt. gr.	dwt. gr.	oz. dwt. gr.			
896	Onehunga	Onehunga	1 0	1 14	...	...	1 oz., nearly	From heap	Moderately fine.
899	Criterion	Shamrock	2 3	...	...	...	Unascertained, small	,, ,,	Mod. fine, pyritous, heap 500 tons
864	Una	Una	2 6	1 20	1 17	...	¾ to 1½ oz.	,, ,,	,, ,, ,, ,, 300 ,,
903	Bull's	Berkeley Castle	2 10	...	...	2 18	1½ oz.	,, ,,	,, ,, ,, ,, 40 ,,
,,	,,	,, ,,	2 11	...	...	...	1½ oz.	From shoot	
904	Onehunga	Scottish Chief	2 11	...	...	...	1 oz.	,, ,,	
873	Tararu	Golden Crown	2 14	2 17	2 11	...	12 dwt. to 1 oz.	From heap	,, ,, very ,, ,, 1000 ,,
867	Prince Alfred	Young American	2 22	2 20	...	...	1½ oz.	,, ,,	Fine, colour reddish ,, 200 ,,
	Goodall's machine								
888	Kuranui	Kuranui	3 1	4 7	...	...	1½ oz.	,, ,,	Mod. fine ,, ,, ,, 400 ,,
886	,,	...	3 16	...	...	...	1½ oz.	From shoot	Fine, colour red.
880	Souter's	Flying Cloud	3 20	4 0	6 17	8 12	2 oz.	,, ,,	,, very pyritous.
877	Tramway	Just-in-time	4 0	5 17	7 7	...	...	,, ,,	,, ,, ,,
878	Hauraki	Mariner's Reef	4 7	...	...	...	2 oz.	... [pit	Mod. fine, very pyritous, 65 tons.
889	Moanataiari	Moanataiari	4 14	...	...	...	½ oz.	Fm. setlng.	
898	Criterion	Waitemata	4 14	...	...	8 23	1 oz.	From shoot	[reddish.
924	Flora Macdonald	Ladybird & Hnd. of	5 1	...	...	...	6 dwts.	,, ,,	Mod. fine, feebly pyritous, colour
884	Hunt's	Hunt's [Frndshp.	5 2	8 14	...	...	A little over 2 oz.	From heap	Very fine, had been calcined.
891	Kuranui	Long Drive	5 9	...	...	...	2 oz.	,, ,,	Very pyritous.
868	Prince Alfred	Inverness	5 17	6 2	...	...	4 to 5 oz.	From heap	Fine, colour red, quantity 50 tons
879	Golden Crown	Golden Crown	5 19	10 20	10 22	12 3	¾ oz.	,, ,,	Very pyritous.
872	Russell's	Little Nell	5 20	7 4	...	...	¼ oz.	From shoot	Moderately fine.
883	Hunt's	Hunt's	6 10	5 23	...	...	2 oz.	,, ,,	Fine.
927	Una	Una	7 14	...	...	...	...	,, ,,	Very fine, feebly pyritous, reddish
911	Hague Smith's	...	7 21	...	...	8 1	1 oz.	,, ,,	Fine, ,, ,, ,,
912		Wandering Star	7 22	...	...	...	1½ oz.	,, ,,	,, ,, ,,
865	Una	Una	8 6	14 8	...	...	1 to 2 oz.	,, ,,	,, colour pale red.
887	Kuranui	...	12 22	...	...	...	2 oz.	From heap	Pyritous, quantity 500 tons.
871	Russell's	City of Dunedin	13 2	...	15 19	...	2 oz.	From shoot	Coarse, non-pyritous, blk.-brown
866	Tookey's	Belfast	1 13 0	...	14 8	...	5 oz.	,, ,,	Coarse.
,,	,,	,,	1 5 21	...	17 5	1 9 2	4 to 5 oz.	From heap	Rather coarse, pyritous, 60 tons.
897	Golden Crown	Golden Crown	1 19 18	...	...	...	...	From Perry's heap.	,, ,,

RESULTS of the ANALYSIS of certain of the GOLD ALLOYS referred to in Table, showing the proportion of Gold to the Silver and other Metals.

No.	Per-centage of Gold.	Per-centage of Silver, &c.
911.	43·2	56·8
883.	45·4	54·6
887.	48·1	51·9
866.	49·6	50·4
892.	49·7	50·3
897.	50·2	49·8
890.	53·4	46·6
912.	53·7	46·3
879.	56·4	43·6
890.	57·1	42·9
865.	57·3	42·7
871.	60·6	39·4

Restricted, as I necessarily was, in the quantity of alloy for analysis, I was unable to determine the per-centage of any other metal possibly present along with the gold and silver, but with reference to the quantity of these, I believe it to be uniformly small.

As a general rule, the employment of cyanide of potassium in the amalgamation, raised the proportion of silver to that of the gold in the resulting amalgam, but all the results in the fourth column refer to the gold obtained by using the burdan, in which case the cyanide was never administered.

RESULTS of the Examination of various samples of PYRITES, for GOLD.

No. on Lab. Book.	Name of Battery and Claim.	Rate of yield per ton.			
		To Burdan.	Do. Roasted.	To Mortar, Roasted.	Assay yield of pure Gold.
		oz. dwt. gr.	oz. dwt. gr.	oz. dwt. gr.	oz. dwt. gr.
882	19. Perry's Battery ...	...	...	8 14	...
890	27. The Moanataiari ...	1 17 9	...	1 14 8	1 11 9 1 12 12
892	29. Kuranui, Long Drive	4 2 16	3 17 10	...	3 17 11

No. 882 was concentrated by hand; 890 and 892 were taken from the buddle. All these samples were nearly pure iron pyrites.

EFFECT of the use of SEA WATER, &c.

Only one series of experiments was performed for ascertaining the relative effects of the use of sea, mineral, and rain water, in the process of amalgamation.

Some tailings from the Inverness claim were used, and were, as usual, well mixed before being divided off for the several experiments.

Every care was used to ensure the same conditions in working with the various waters—the same head of water, speed of delivery, etc.

The mineral water was prepared by dissolving 6 grains protosulphate of iron (crystallized) in the gallon of water, prior to use, this being the most common and prejudicial salt existing in the shaft water of the various companies.

RATE OF YIELD PER TON.

		Rain water.			Sea water.			Mineral water.	
No.		dwt.	gr.		dwt.	gr.		dwt.	gr.
868	...	8	17	...	8	14	...	6	1

SUMMARY OF RESULTS.

From a perusal of these tables, the following general results appear:—

1. The amount of gold alloy separable by an almost exhaustive amalgamative process from numerous samples of tailings taken quite indiscriminately from this field has varied from a minimum of 1 dwt. 14 grs., to a maximum of 1 oz. 19 dwt. 18 grs., as calculated upon a ton of the sample, while the assay yield has been from 2 dwt. to 1 oz. 9 dwt. 2 grs. of pure gold per ton for the same samples respectively.

2. The yield thus obtained does not bear any fixed or definite ratio to that obtained in the first instance from the same stuff at the batteries.

3. In respect to quality, the gold given up to this re-amalgamation is generally poorer than that which has been taken at the mills by the first amalgamation.

4. Roasting the stuff previous to amalgamation does not, as a rule, raise the yield of gold alloy; but the gold so obtained is uniformly finer.

In making proper deductions from the results above summarized in reference to the actual loss of gold entailed by the present way of milling, it is necessary to make allowance for the concentration of the stuff in passing through these mills.

The amount of this is not a fixed quantity, but varies with the kind of stuff, the degree of fineness to which it is crushed, the volume and fall of water used, and mode of settling.

It would be difficult, therefore, to do more than make a vague allowance for this loss ; and this is stated by several of the managers of the batteries at from 30 to 50 per cent. upon the stuff before crushing.

I had not time to fully investigate into this matter, but from the few experiments I was able to make in this direction, I believe these figures to be approximately correct.

These experiments were confined to the testing of the actual loss in earthy matter incurred by my particular mode of sampling, as stated on page 71, the greatest loss being for the Una battery, and amounting to 45·3 per cent., while the lowest was 20 per cent.

On the whole, therefore, and considering that the larger proportion of gold lost will remain with the coarser portions of the earthy matter saved, it will be proper to reduce the figures in the fourth column, to about two-thirds of their value, in order to get an approximation to the actual loss of gold upon the actual quantity of stuff crushed.

Subject to the reductions consequent upon making these allowances, the loss of gold for many of these batteries amounts to 30 or 40 per cent. upon that capable of being extracted by careful and prolonged amalgamation, or to 35 and 45 per cent. on the quantity actually present in the stone, as shown by assay.

Compared to the loss experienced on other gold fields, where amalgamation is the process used, this does not appear excessively high. Still, it is very unsatisfactory as regards our present gold-saving arrangements, to know that we are frequently throwing away nearly as much of the precious metal as is saved, and with a view to the reduction of these losses, the main causes of this loss will now be considered.

Causes of Loss.

The principal cause of loss may shortly be stated, for this and other gold fields where amalgamation is relied on, as the want of perfect chemical contact between the gold alloy and the mercury employed.

However much of this may be due to defects in mechanical arrangements adopted for securing the gold, the result of my investigations certainly show that most of it is fairly attributable to causes of a chemical nature, and which the very best mechanical manipulation could but partially overcome.

These may best be discussed and explained so far as possible, with our present imperfect knowledge, by dividing them into those which especially relate to the quicksilver, and those which relate to the gold alloy.

1. Regarding the quicksilver employed for amalgamation.

That this substance generally sickens or "flours" when ground up with pyritous rocks, is so well known and so frequently experienced by all managers of batteries, that it would be superfluous to point out that the true chemical contact we seek is much impeded or even entirely prevented by such a circumstance.

But as several bodies naturally occurring in such rock are capable of inducing this unfavourable state of the mercury, it may be useful, with a view to the adoption of remedial measures, to explain what is, I believe, the general cause upon this gold field.

Whatever has been affirmed about the metallic arsenides or sulphides, sulphur and sulphuretted hydrogen, being frequently or directly active in producing this flouring, I feel convinced the greatest enemy that has to be contended with on this account upon this gold field is protosulphate of iron, or green vitriol.

I do not know that these arsenides or sulphides exercise any *direct* effect upon mercury; it is only the products of their decomposition which appear so to act. And this decomposition is so slow compared to the ordinary speed of amalgamation, that ere it has advanced far enough to practically affect the yield, the whole of the auriferous stuff would have been passed through the mill.

As regards sulphur and sulphuretted hydrogen, the former has not been identified at the Thames, I believe yet, in a free state, and even if it were present, by reason of its insolubility, and comparative non-volatility, its effects upon mercury would be slow. The latter is, on the other hand, very rapid in its effects; but its existence is incompatible with the presence of sulphate of iron, a salt pretty generally diffused in wells and shafts, and porous pyritous rocks occupying superficial situations.

Taking all this into consideration, I incline to the opinion, that not only in this, but in other gold fields, the greater part of the flouring or sickening of the mercury used is due to the action of sulphate of iron.

Another obstacle to amalgamation is sulphate of copper (blue vitriol), but it occurs far less frequently. The Silver Crown, the Golden Crown, and Long Drive claims, and other claims around these, being the most likely places for it.

This salt, however, is not more to be dreaded than the sulphate of iron, indeed, where the copper salt occurs, the iron salt will also occur, and in preponderating quantity.

Both these salts act, I believe, by forming subsulphates of mercury and iron or copper, which persistently adheres to its surfaces.

2. Want of contact, owing to the composition and properties of the gold alloy itself.

In regard to the average composition of these alloys, an analysis of four Thames specimens, from as many different localities, showed that in three of them the metal antimony occurred in very sensible quantity.

Now I find by direct experiment, that antimony is not a metal which readily amalgamates, it is pretty certain, therefore, that it would communicate something of its negativeness in this respect, to whatever gold alloy it might occur in ; indeed, I have observed from my own experiments, the very slow rate at which these kinds of alloys do amalgamate.

Regarding the properties of these gold alloys themselves in more intimately affecting the chance of true chemical contact, a hitherto quite unsuspected one has been discovered in the course of these investigations.

It has become apparent that the surface of native or artificially-prepared gold, even of extreme fineness, energetically absorbs sulphur or sulphuretted hydrogen.

When these surfaces are so affected, they absolutely fail to have such contact with mercury as to enable the metals to amalgamate, at least such is the case at common temperatures, but they again do so readily when treated with cyanide of potassium, free chromic acid, or chloride of lime.

Raising their temperature to a red heat, also renders them amalgamable, whether or not cooled before the introduction to the mercury, but the heat of boiling water does restore the affinity of the surface for quicksilver.

Now several specimens of native gold from this district, and also from others where the gold is exceedingly pure, show no disposition to amalgamate on contact with mercury, while others are only very partially affected. Nor is it promoted or facilitated in any instance by giving them contact for a lengthened time with boiling water. So that this non-amalgamation cannot be referred to the intervention of bubbles of air adherent to their surfaces.

In these cases, as in those previously cited, contact with solutions of cyanide of potassium renders them easily and quickly amalgamable, and so also heating them, except where very cupreous, when the oxide of copper forming by contact with air at high temperature, acts as an invisible varnish.

All the specimens chosen for experiment were free from any discernible ferruginous or other stain.

Comparing the re-action of artificially sulphurized gold with that of various specimens of native gold, leads us to assume, that in many cases where the amalgamation of these specimens is slow, or does not take place, the obstacle is sulphur, most probably existing in combination with gold as an auriferous sulphide.

The bearing of these results upon the subject under investigation is obviously important, as the exercise of this hitherto unsuspected property of gold must have a very prejudicial effect upon the amalgamation processes as practised in all reef workings.

Sulphuretted hydrogen is too common a substance, or at least the materials required for its generation are too widely spread, to allow us to hope that any larger portion of the exposed superfices of our native gold has not been affected by it to a greater or less extent, and so rendered to a corresponding extent unamalgamable.

REMEDIES AGAINST LOSS.

1. Relative to the general mechanical arrangements of the various batteries; it would not be easy to propose any improvements in these; and any new ideas on this subject, the fruit of such a cursory or superficial inspection as I had an opportunity of making, could scarcely have any practical utility.

The absorbent property of gold for sulphuretted hydrogen, and the great likelihood that much of the Thames gold is as it were, thus tarnished with sulphur, suggests the prolonged grinding of the auriferous rock, as a partial remedy, not so much to ensure fineness, as to ensure *abrasion* of the enclosed gold granules.

The results shown by the use of the hand burdan, inform us not only how much can be extracted by prolonged grinding under certain conditions, but that most of the residual gold from the batteries is in a free state.

Doubtless the good results are mostly attributable to the greater extent of new clean surface thus exposed to the mercury. Whether any extensive change in favour of apparatus having greater grinding action could be profitably made, is a question which experience alone can certainly decide, but I think it very probable.

The *Chilian mill* seems too slow, besides, much complaint is made that the loss of mercury is very great by this mill. With the burdan, though certainly an excellent apparatus for rich hand samples or *blanketings*, there is evidently on the part of the few managers who use them, such a disposition to run them either too fast or with so much water, in fact to give them too much work, that one does not like to recommend them at all. They are rather deficient in grinding power for profitable use on a large scale as at present constructed; but if some means could be devised for increasing this considerably, say by fixed shoes instead of balls, or a mixture of the two, they might be found to work well.

Concentration of the heavier portions of the auriferous rock, and the treatment of the residues by special processes, certainly merits great attention.

2a. Losses occasioned by the condition of mercury used for the amalgamation.

As the principal cause of the flouring or sickening of mercury upon these gold fields is the presence of sulphate of iron in the reef stuff, and as this salt is freely soluble in water, it will naturally occur that one way of preventing the mercury being affected in this manner, is to wash the auriferous stuff impregnated with this salt, prior to stamping.

Whether such a process could be profitably used is a question for experience to determine. It could only be applied with any considerable saving effect in those cases where the reef is porous and incoherent.

To a certaint extent, where good water is used for the stampers and tables, the ill effects of the metallic sulphates present in the reefs are diminished.

In reference to the kind of water used for these purposes, I would desire here to remark how necessary it is to abstain from the use of mine or shaft water for the crushing or amalgamating apparatus of the battery, except, indeed, it is quite, or at least nearly, free from metallic sulphates, a circumstance rarely occurring.

The use of water for these purposes containing any notable quantity of sulphates, acts even more prejudicially than the sulphates naturally existing in the stuff itself, even were they ever so abundant; flouring in such a case becomes, as it were, a chronic complaint.

The greatest possible quantity of good water that the incline of the copper plates will safely allow, should be employed, since the solution of these metallic salts is thereby weakened, and so correspondingly less productive of harm.

In a manner more strictly chemical, it is easy to destroy or overpower this tendency of mercury to flour in presence of these or any other substances, but for stampers and tables, where such immense quantities of matter are used, it would scarcely pay to manipulate the water itself.

For this reason, in the case of the battery tables, it is only the mercury we can profitably influence by the addition to it of sodium or the sodium amalgam, as suggested by Mr. Crookes.

This substance does not appear to be, however, at all extensively used on the Thames, for what reason I am not aware, but probably its cost.

In working up the blanketings either the water or mercury should certainly be treated chemically; the blanket slimes being generally very pyritous, and the amalgam present in a flouring condition.

Cyanide of potassium, which appears to be the only agent yet administered to the water for keeping the mercury bright, acts admirably. It is a solvent for the metals gold, silver, and mercury, singly, but I have found, experimentally, that in the presence of the three together it only dissolves the silver and mercury, at least, to an appreciable extent, and there is, therefore, not that loss of gold incurred from its use which some persons have anticipated.

Its expense however requires that it only be applied to that work which a cheaper salt cannot effect. Thus the neutralizing of the acid substances in the blanketings may be safely and cheaply performed by washing soda, and after the liquid and solid matters are feebly alkaline, then the cyanide can be added, till any mercurial globules in sight in the well-stirred liquid are bright and sharply defined.

2b. With reference to the remedies to be employed against the newly discovered absorptive property of gold for sulphuretted hydrogen, I would remark, that the frequency with which natural surfaces of native gold must be tarnished by this substance, renders it a matter of importance to ascertain the state of these surfaces, and in case of their being sulphurized, to take every practical means for effecting the exposure of the pure metal to the action of the various amalgamators.

We may have the mercury ever so clean, ever so positive, as it were, to the gold, we may even put it in an electrical state, as was proposed to me by an enterprizing gold mining manager; but if the gold is coated with a continuous film of any negative substance, however thin, it is certain there could be no contact between the two metals, and consequently amalgamation could not proceed. Indeed, we have a far better chance of obtaining amalgamation when of the two metals the mercury is the tarnished one, since even then it yields a tolerably clean surface to the slightest pressure or friction.

There is no doubt that the operation of extracting the stone from the reef, and the present method of working it at the mills, tend greatly, by mere abrasion, to remove old surfaces, and thus expose clean metal.

These should be powerful remedial measures in themselves, though their utility in this respect has not been before suspected. I do not know that we can push this mechanical abrasion much further than is at present done, for it seems there is a point, or rather a degree of fineness, passed which the proportion of mercury and amalgam which escapes is so large as to neutralize the good effects.

The ease with which gold is scratched by hard and angular surfaces, such as those of crushed quartz, make it probable, however, that the mere stirring of the auriferous sand after it has left the stampers, without reducing its coarseness sensibly, should be sufficient to clean the surfaces of any exposed gold granules that had escaped with an adherent film of sulphide.

Chemically, this abrasion may be performed with a greater diversity of re-agents than those which are available for the brightening or cleansing of mercury.

Some of the methods for accomplishing this have been already incidentally stated, but the same objections against treating the water, to prevent flouring of the mercury, also apply here.

Crooke's sodium amalgam effects the immediate removal of the sulphurized film, metallic sodium combining energetically with sulphur, and decomposing its compounds rapidly. This accomplished, then there is nothing to intervene between the gold and the mercury, and amalgamation commences.

It is pretty certain the good effects frequently attending the use of this amalgam, are properly referable to this action on the thin films of sulphur compounds attached to the surfaces of the gold to which it is applied, and not to the action of the sodium upon the mercury.

It has been stated that except in case of the more cupreous native golds, the process of roasting these sulphurized ores removes the sulphur, and renders the enclosed gold more amalgamable.

But though these good effects upon sulphurized gold are palpable enough on a small scale, it is conceived that on the large scale it would not be equally easy, but in fact likely, by the application of a similar process, to make the gold worse than it was at first.

Unless the roasting be thoroughly done, the whole of the sulphur driven off or oxydized, and the temperature towards the end of the process raised or kept at a dull red heat, it is certain that gold which might have been cleaned or exposed by the first part of the process would be more or less re-sulphurized towards the end of it.

But the subject of the natural sulphurization of gold has been so recently opened, that it would be as yet premature to speculate as to the precise effects of any process we may employ as a remedial measure.

The first step should certainly be to ascertain whether there are any natural processes now in operation, or that could be brought to operate for the removal of this sulphur.

We want to learn the effects on such gold of long exposure to air, and to the various oxydized and oxydizing substances which occur in superficial strata and workings.

When we have fully investigated these, and learned what action, if any, they exert, we can see better what would be proper to prescribe as antidotes.

Meanwhile it may not be out of place here to conclude this part of the subject, by indicating the results obtained in the laboratory to this date, bearing upon these various points.

For convenience of future reference, I will number the experiments consecutively.

1. Pure gold, kept in strong solution of protosulphate of iron for one week, in an open vessel and then washed, amalgamated very well at the end of the term.
2. Sulphurized gold, treated in manner detailed above, would not amalgamate in the least.
3. Pure gold, freely exposed to the air three days, at a distance from laboratory, readily amalgamated.
4. Sulphurized gold, exposed as in No. 3, for six days, would not amalgamate.
5. Pure gold, placed in solution of protosulphate of iron, along with sulphide of antimony, was rendered unamalgamable in twenty-four hours.
6. The same effects followed when iron pyrites (slightly cupreous) was substituted for the antimony sulphide.

The experiments detailed are obviously too limited in scope and number to allow of any very specific deduction being founded on them, but their general tendency is greatly to confirm me in my conviction, that in most cases native gold must be sulphurized; besides this, it unfortunately appears as if there is but little chance of any natural process or agents in an ordinary way antagonistic to the permanency of such surface deposits.

But for the proper and general investigation of this subject, the co-operation of those having charge of the mines and batteries is most necessary, as circumstances which could hardly be observed by any outsider, require to be accurately recorded.

It is the chemical condition of the natural, not the abraded surface, we want to test, and this necessitates extreme care in the collection of samples.

Further investigations are required, however, in this direction, particularly to inform us as to the chemical condition of these natural surfaces; it is not often that they can be obtained with such certainty that their chemical examination would be useful, a touch of the finger might render clean surfaces unamalgamable, while the accidental contact with any moderately hard substance, might on the other hand so abrade a sulphurized or dirty surface, as to render it amalgamable.

Pending these investigations, however, I am inclined to think the greater portion of the loss, as stated in columns 4, 5, 6, is made up of gold which has become sulphurized upon its surfaces, and remained unabraded.

Gold thus sulphurized is rendered amalgamable by contact with cyanide of potassium, chloride of lime, chromic acid, and also by roasting; but for further particulars of my researches on this subject, I beg to refer to a paper entitled "The Absorption of Sulphur by Gold, and its effects in retarding Amalgamation," read before the Wellington Philosophical Society.

To the hearty co-operation of the directors and managers of the various Mining Companies this report is indebted for any value it may be found to possess; and I would desire here to tender my thanks for the general courtesy I have met from them in the performance of a task which certainly appeared, though erroneously, to be somewhat of an inquisitorial nature.

MATRIX OF THE GOLD.

I was not able to observe any other matrix than quartz, or highly quartzosed rocks where the gold at least was in paying quantity.

These quartz veins or quartzose rocks generally run through a white or grey tufaceous granular rock, which, as also the quartz, is generally pyritous.

In two cases the pyrites was roughly separated from a quantity of some of this tufaceous rock, free from all appearance of quartz veins, and these, when separately assayed, gave no positive indication of gold.

In another, some iron pyrites from the Long Drive claim, selected with the greatest care, so as to avoid anything like a quartz vein, gave distinct traces of this metal when analyzed. Both samples occurred in the same kind of grey granular rock as previously cited.

Associated Minerals.

The minerals usually associated with the gold of this district, are pyrites, sometimes cupreous, and sesquioxide of iron; indeed, iron in some form or other is a constant associate—in the lower, or more compact strata, as the sulphide; in the upper and more open parts, as the oxide, or sulphate, with more or less pyrites.

Along the walls of the old drives, the conversion of the pyrites originally present in the rock, to the oxide and protosulphate of iron, is at times complete for some distance in the wall.

In some of the claims along the upper and middle portions of Tararu Creek, manganese oxides occur along with the gold to the almost entire exclusion of iron compounds.

In others, but these are comparatively few, sulphide of antimony with the various products of its metamorphis, is largely associated with the gold, this is particularly the case at the claim of the Criterion Company.

Heavy spar (sulphate of baryta), Witherite (carbonate of baryta), Black-jack (sulphide of zinc), Calamine (carbonate of zinc), Diallogite (carbonate of manganese), Galena (argentiferous), occur less frequently.

Crystallized silica (rock crystal) and calcspar among the non-metallic minerals, are both very generally diffused.

A statement of the results of the examination of the more interesting of the Thames specimens received or collected, is here annexed.

No. 870.—From the Silver Crown claim. Presented by Mr. MacLaren, for examination as a silver ore.

An excellent specimen of zinc blende (sulphate of zinc); it is well crystallized, and both the yellow and black varieties are exhibited.

Associated with this ore, is a little argentiferous galena and copper pyrites; the matrix is quartz.

No. 874.—Diallogite (carbonate of manganese), with calamine (carbonate of zinc). From a claim, high up on the Tararu Creek. Presented by the manager of Russell's battery.

The Diallogite of this specimen contains a portion of carbonate of lime, but the amount of this has not been ascertained yet; it is coloured with oxide of manganese, and crystallized in large rhombohedrons.

The carbonate of zinc forms lustrous colourless transparent crystals, attached to the former, but always external; these are well shaped, but comparatively small; they are interspersed, somewhat rarely, with small rock crystals.

No. 902.—Galena. Long Drive claim. Obtained by Mr. D. Monro.

Examined especially for silver (by request); yielded only traces of this metal; in all probability the whole of the silver exists as a sulphide, in combination with the lead ore, since all galenas contain more or less silver.

No. 875.—Manganite (hydrous sesquioxide of manganese). Tararu Creek.

Occurs in small columnar crystals, lining a cavity in an earthy-looking quartz rock.

It was presented by the manager of Russell's battery.

No. 881.—Copper Pyrites. Golden Crown claim.

Occurs in small abruptly-terminating veins, in a drive recently made in this claim.

It contains nearly 9 per cent of copper.

No. 900.—Stibnite (sulphuret of antimony). Criterion claim.

A large block of quartz upon two faces of which nests of Stibnite crop out in large radiating crystals. This mineral is also interspersed throughout, but very irregularly, and generally in isolated crystals.

The yellow stains appearing upon portions of the quartz and stibnite, is due to the presence of Cervanite (oxide of antimony), while the red substance forming small patches in the above (the cervanite), is Kermesite, or the oxy-sulphide of the same metal.

In and upon the less antimonial portions of the specimen, numerous small colourless rhomboidal crystals occur; these consist of heavy spar (sulphate of baryta).

The whole of the specimen is thickly impregnated with small cubic crystals of iron pyrites (mundic of the digger), which is auriferous.

The antimony ore has been specially tested for silver, by the wet process, the results being strictly negative.

A great quantity of the quartz from this claim is more or less antimonial, to which circumstance the manager, very properly, ascribes the cause of much of the loss he experiences in milling it.

No. 906.—Tufaceous Rock. Hape Creek.

This stone outcrops about one mile up the creek, forming a bold bluff close to the tramway. It has been used for the formation of a reservoir at Goodall's battery, and as it is in contemplation to extend its use for the general purposes of a building stone, an opinion was requested by Mr. Simpson, the Provincial Assistant Engineer, as to its probable durability when so applied.

It is a moderately hard coherent greyish slate-coloured rock, of granular and massive structure, and homogeneous for considerable distances.

It is easy to work and dress, and can be quarried in large masses if desired.

In one form or other it is a very common rock, but it occurs at this particular place in position and quality rarely combined; there is however a stone cropping out at the next point above this, very similar, but sensibly harder, and in its mineralogical character partaking of an agglomerate.

In their chemical composition both these stones no doubt compare with No. 461; they are certainly complexly constituted rocks, prone to chemical change, but whether such change would have an indurating or a disintegrating effect upon it, can scarcely be determined otherwise than by actual observation.

It is proper to state in respect to this, that there were on view several roughly squared blocks, which had been lying at this quarry for six months, and the angles so exposed seemed quite sharp and well-defined, while the stone itself appeared slightly harder than that recently quarried.

No. 913.—Manganese Ore (hydrous oxide). Tararu Creek. Per Mr. Robinson, Reporter to the *Thames Advertiser.*

This was taken from the Yankee Doodle claim, by Mr. Thorborn. It occurs very plentifully in a rich leader recently struck in this claim.

No. 914.—Crystallized Sulphate of Iron. Long Drive claim.

Uniformly occurring in all the old drives and workings of this claim, where the enclosing rock is or has been pyritous.

It is this salt which, as before remarked, is I believe the most actively concerned in the flouring of quicksilver.

No. 923.—Native Lead. Presented by Mr. R. Raithby.

Obtained from the heavier matters of the wash of a creek; locality not stated.

It is in pieces more or less rounded, some indeed quite spherical, and about the size of small shot, to which it bears much resemblance. I was assured, however, there was but little possibility of it being anything of this sort, it being taken very soon after these diggings commenced.

Lead, in its native state does sometimes, but very rarely, occur naturally; when it does, it is generally in flattened buttons, but now and again in small spheres, a form which the attrition of fine sand around it would certainly have the tendency to produce.

No. 929.—Chlorite. Tararu Creek.

This occurs with more distinctive characters than usual in the damper crevices of the white tufa rock, some distance up this creek.

No. 931.—Selenite (gypsum). Presented by Mr. Macdonald.

A very fine, beautiful, crystallized specimen. This mineral is, as yet, rarely found in large crystallizations, though generally diffused among the calcareous and pyritous rocks of this district.

No. 917.—Cavernous Quartz, with Rock Crystal and Dioptase (silicate of copper). From the Wonder claim.

It is in parts iridescent, from the presence of films of hematite upon its surfaces, which have varying degrees of thickness.

ON THE GEOLOGY OF THE CAPE COLVILLE DISTRICT.

BY DR. HECTOR.

April, 1870.

COROMANDEL.

THE gold mining district of Coromandel was the earliest discovered in New Zealand, and has undergone so many fluctuations, that its future prospects cannot be understood without some reference to its history at different stages of development.

When Professor von Hochstetter visited Coromandel in 1859, or eight years after the first discovery of the gold, mining operations were almost entirely suspended, and the total value that had been obtained was only £1,200 sterling.

His opinion was that the "Coromandel gold originates from quartz reefs of crystalline structure, belonging to palæozoic clay slate formations of which, under cover of trachytic tuff and conglomerate, the mountain range of Cape Colville Peninsula consists."*

With reference to the last mentioned formation, he remarks that it "occurs along the coast in the most different state of decomposition, from the hardest rock to a soft clay mass, and in various places broken through by doleritic and basaltic dykes. Siliceous secretions, in the shape of chalcedony, carnelian, agate, jasper, and the like, are of frequent occurrence in these tuffs and conglomerates, likewise large blocks of wood, silicified and changed to wood opal. By local geologists, these trachytic rocks were erroneously taken for granite and porphyry, and by a gross mistake the most sanguine hopes were based upon the notion that these silicious secretions might be auriferous quartz veins." (*Ib.*, *loc. cit.*)

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* *Hochstetter's New Zealand*, p. 96.

Professor Hochstetter thus clearly expresses his opinion, that the more recent volcanic rocks of the district, to which he alone refers in the above passage, would not prove to be auriferous, a view which I think is fully borne out by our extended knowledge of the field. The gold is not, however, as he supposed, derived only from quartz veins in clay slates, for, as Captain Hutton very justly points out in his Report on this district (*ante*, p. 2), the area of these exposed at the surface is very limited. On the other hand, Captain Hutton in the same report does not distinguish between the comparatively modern breccias and agglomerates, which he describes as containing blocks of variously coloured scorias and lavas, and the more ancient formation of green tufaceous sandstone and porphyry, in which most of the auriferous lodes occur.

My first visit to Coromandel was in June, 1864, at which date the mining operations were being conducted with considerable activity, but confined to a very limited area. The following notes, made at the time, indicate the state of our knowledge of this mining district at that date, and before additional experience of the manner in which the mineral lodes in other parts of the Colville Peninsula had been obtained.

On entering the harbour, the rocks on each side are seen to be stratified, and dipping to the westward from the land, but rising again to the north and south, and on landing at Beeson's, on Wanganui Island, were found to consist of trachyte tufa and conglomerate. The included fragments of trachyte, often of large size, are porphyritic, with crystals of hornblende. In some places beds of compact trachyte occur, but this is probably only a variety of the tufa which has been more consolidated, or composed originally of finer grained material. These tufas decompose freely to a ferruginous earth, which is sometimes bleached white, and frequently traversed by veins of quartz.

Where excavations had been made in this formation, in search of auriferous reefs, the rock appeared to be a mottled purple trachyte porphyry, traversed by bands of felspathic clay—probably decomposed dykes, which contain masses and veins of crystallized quartz,—also, a soft vein in the same description of rock, 8 to 10 inches in width, containing masses of horny quartz. These veins underlay to the E., and strike N.N.E. No gold has been found in any of these veins.

At Keevin's Point, a spur of the hills terminates in a bold ridge composed of light grey tufaceous porphyry, containing iron pyrites. The hill has been prospected in all directions by the miners, and the existence of two distinct reefs established. These consist of banded quartz of a blue colour, with cavities lined with crystals. The rock appears to be originally a claystone porphyry, in which veins of segregation have been formed. The rock contiguous to these veins has been converted into a mottled pipe clay, stained with oxides and carbonate of iron. No gold has been found in these veins, which strike N. 35° E., and dip eastward at 40 degrees.

The chief diggings are up Driving Creek, two miles from Keevin's Point, in a N.E. direction towards the highest point of the range. Only one mine was in active operation (in 1864), having a 5-stamp battery at work crushing a blue sub-crystalline quartz.

The main reef is 6 to 8 inches thick, strikes N. by W., and dips to the west at 45°.

Since the new batteries began work they had crushed 40 tons, with a yield of 1,120 ounces. Three shafts were sunk the depth of 150 feet, and one main level put in on the reef for 200 feet. Two other "leaders" occur parallel with the main reef, with 30 and 40 feet of white rotten rock between. The lower or east side of the main reef is a very hard fine grained breccia, charged with pyrites. Each leader consists of a band of bluish mullock, containing strings and nodules of quartz, generally quite detached, and frequently very highly auriferous. From practical trials by Mr. Ninnis, the pyrites obtained as tailings from the mill contains gold in the proportion of 7 dwts. to the pound. It is not established, however, that the pyrites from the rock contain this large proportion, or only that which is derived from the vein stuff put through the mill. As much of the quartz is evidently rich to the eye, these portions are selected and crushed separately as specimens. A crushing of 1,706 lbs. of such specimens, gave 2,198 ozs. of gold. The rest of the ore from which the above specimens were picked weighed 100 tons, and yielded in the proportion of 4 ozs. per ton. The total produce, therefore, taking the gold at £2 15s. per ounce, was £7,143, representing the return of work executed from July, 1863, to May, 1864.

The yield for the vein stuff is therefore about 26 ozs. per ton.

No calls had up to this time been required to be made on the shareholders in this claim, as the first ground worked was the richest.

From the shaft nearest Driving Creek the main reef had been worked out to "day" in the bed of the stream, the vein being very rich as the surface was approached. It was from the outcrop of this reef that the rich specimens found in the creek must have been derived, which first attracted attention to this gold field. The stream winds about among the outcrops of the various reefs that have been discovered, but owing to the nature of the rock has not formed any proper water-worn gravel or "wash." The rock is decomposed very freely to a red soil, which is washed down as a coating of clay on the surface. The reefs can be traced as blue bands through the red rotten rock. They are rarely more than 10 inches in width, and, as a rule, lie parallel to a mass of breccia which forms barren ground cutting off the gold to the east, for although superficial quartz veins have been found in this breccia, they have never proved worth working.

In the main or lowest reef are water-worn quartz pebbles, mixed with the same mullock or dark clay, in which are embedded the masses of crystallized auriferous quartz. The breccia consists of angular fragments of trachyte poryhyry and other rocks, but no quartz.

Imbedded in the surface soil, and lying in the bed of the creek, are masses of dolerite, and a dyke of the same rock appears north of Keevin's Point, but no proper volcanic rocks have ever been met with in the underground workings when they have proved auriferous.

On the occasion of a second visit, in February, 1866, I found many more claims occupied, but still only in the vicinity of Driving Creek, and from their being chiefly among the old workings which had been abandoned for many years, no additional information was obtained.

In April, 1868, after the discovery of the richer field at Shortland, the mining operations were again restricted to the Kaipanga mine. This mine had then reached a depth of 300 feet, or nearly to the sea level. I found that the lode at this depth had the appearance of a fissure, with a well-defined hanging or west wall, but no regular vein stone. The quartz occurred in larger concretions than in the higher parts of the mine, and these concretions contained, in addition to the gold and iron pyrites, native arsenic and crystals of calcite. Some of the specimens from this depth were exceedingly beautiful, but the main lead ceased to be practically remunerative owing to the scarcity of auriferous ore at this depth.

On the spurs extending from the high range at the head of Driving Creek, there were, in 1864, several drives and shafts on small leaders of quartz in the decomposed porphyry, which passes into what the miners term sandstone, a few fathoms below the surface. The quartz then changes from the friable crystalline texture into a compact blue variety, containing a large admixture of iron pyrites. On the surface of the spur leading to Tokatea Peak, large blocks of crystalline quartz are strewn in a zigzag line, having a general N.E. direction. The principal claims were Murphy's, in which there is a drive and shaft; the Commercial, where there is a shaft 120 feet deep, sunk in the bottom of the gully; and the Royal, in which claim a drive has been put into the spur for 150 feet, to meet a shaft sunk in the crest of the ridge. All these are excavated in the porphyritic tufa, in the hope that small leaders which cropped out on the surface would change to reefs as they increased in depth, but they did not prove successful adventures in any case.

As all these works have been abandoned for many years, and are now inaccessible, I have stated the above facts as observed at the time, and will now proceed to the general consideration of the structure of the district, from the result of a recent examination, in the course of which I crossed the range to Kennedy Bay, and returned by a different route, from Wangapoa. I also re-examined the valley of the Matawai Creek, following it up to the Tiki diggings, which had been discovered since my previous visits to the district.

In crossing to Kennedy Bay, from the old diggings at Driving Creek, I found the difficult path by which I scrambled to the top of the Tokatea Range, in 1864, now superseded by a well-cut bridle track, the cuttings along which afforded the additional advantage of clean sections of the rocks.

The general direction in which the claims have been taken up towards the top of the range is in a N.N.E. line, continued from Keevin's Point through Driving Creek and on to the Tokatea reef. This great "blow" of quartz, as the miners term it, strikes to the N.W., and therefore crosses the auriferous belt nearly at right angles.

The shafts and drives on the Tokatea Hill, and also a few of the road cuttings which penetrate the hard rock, show it to be the same grey tufaceous sandstone, full of mundic, as at Keevin's Point and Kapanga, thus proving this rock to extend in a narrow belt from the sea level to 1,600 feet altitude. On the surface it is everywhere so decomposed as to be scarcely recognizable from patches of alluvial slope deposit. The auriferous reefs are generally in the decomposed rock, and, as at Shortland, have a general direction parallel with the boundaries of the formation, or N. 40° E.

The eastern descent of the range, to Kennedy Bay, is at first very steep, and so far as could be judged from the superficial appearance of the rock, the first slope is composed of green decomposing sandstones and breccia, like the barren rock on the east side of Driving Creek.

These are succeeded by what might be taken for crystalline dykes, but which are probably only highly metamorphosed beds of the sandstone, containing mundic in cubic crystals.

The low spurs along the eastern base of the range are formed of blue and yellow felspathic slate ; while the hills along the coast, both north and south of Kennedy Bay, are formed of the volcanic agglomerates presenting the same broken, but distinctly stratified, character as on the west side of the range.

The country occupied by the volcanic rocks has a very distinct appearance from the central portion of this part of the range, which is composed of the tufaceous and porphyritic sandstones, and felspathic slates.

The eastern limit of these rocks is marked by a bold scarp, which is seen in a sketch (No. 1), taken from Kennedy Bay, looking S.W., in which *a* is the the Tokatea peak, forming the culminating point of that portion of the range which is formed of the metaliferous rocks. The junction is even better shown in the sketch (No. 2) which is taken in the opposite direction, *a* being the north head of Kennedy Bay, and *b* a gap that leads through to Waikawau Bay, the hills between the two points being formed of the volcanic rocks.

In passing round the coast, from Kennedy Bay to Wangapoa, fine sections were exhibited in the cliffs of this volcanic formation, as shown in the section (No. 3), and from the frequent alternation of agglomerates and tufas, intersected by dykes in various directions, the formation has all the characters of a superficial or submarine volcanic accumulation. At Wangapoa Harbour this formation is confined to the hills near the coast, as it was not met with in ascending the Watikooti stream in re-crossing the range towards Coromandel. The first rock met with in this section, was the green indurated sandstone, interstratified with silicious slates containing mundic.

The final ascent to the summit of the range is very steep, and passes over several alternations of rock, the changes being generally indicated by knobs on the spurs. The rocks are chiefly silicious and clay slates weathering to various shades of white, pink, and red.

The crest of the ridge is of vertical beds of sandstone, and descending the western slope, a succession of slaty beds and indurated clay stones is met with. To the north of the part of the range crossed by the track is a low dip, near which the abandoned Wangapoa diggings are situated. The rock is the usual grey porphyry tufa, but the reef was remarkable, from its consisting chiefly of a black ferruginous substance, entangling the gold in finely-divided leaves and filaments.

The general impression I formed of the structure of this interesting range of mountains is shown in a section (No. 3), extending from coast to coast through the Tokotea.

The above may be considered as the northern district of Coromandel, and in the south district may be included the abandoned diggings on the Patawau, the alluvial diggings on the Matawai, and the recently discovered reefing district on the top of the range behind the Tiki.

The first mentioned of these is about three miles south of the Winyard township, where, in 1862, about £200 worth of gold was obtained, of better quality than is usually obtained on this gold field. It appears to have been confined to one small tributary of the creek from the northeast, which flows through decomposed argillaceous slates traversed by irregular quartz veins. A spur, consisting of these slates, had been cut through by a drive 300 feet long, communicating with the surface by a shaft, but no auriferous leader was discovered.

The Matawai is the next stream to the south from the Patawau, and the spur which divides leads back to that part of the main range where the Tiki reefs have been discovered.

The section afforded by the valley of the Matawai is very interesting. The junction of the volcanic agglomerate, which forms the peninsula separating Coromandel from Manaia harbours, with the older rocks, is well exhibited below the old mill, where the Matawai and Waiau streams meet.

Following up the Matawai Valley, the stream is seen to flow over vertical ledges of green and blue slates, sandstones, and porphyritic breccias, containing a small quantity of pyrites, and having a general N.W. strike. On the steep spurs above the creek the same rocks are very much decomposed and altered in appearance.

The creek is skirted by patches of coarse red gravel, containing coarse gold. These deposits were supposed, when I examined the creek in 1864, to have been worked out, but I lately found several parties of diggers systematically turning the river, and obtaining a fair return of gold, generally in the form of nuggets, one or two having been obtained which weighed over an ounce. The quality of the gold obtained is the same as at Driving Creek and at the Tiki diggings in the back range, and not like that on the Patawau side of the spur. The gold has been traced in these gravels for about two miles, to where a branch creek joins the stream from the north. No trace of gold has been found in the other, or south branch, which rises near Castle Hill, which is a mass of trachytic agglomerate.

Ascending the hill, at 800 feet above the creek, on the north side, is the Golden Crown claim, which is the furthest south of forty claims that have been taken up along the ridge, constituting the Tiki diggings. Several drives and shafts enabled me to examine the formation, which is the same decomposed blue slaty sandstone as at Patawau Creek. Two distinct leaders of quartz had been found, the one running due north with a westerly underlay, and the other N. 28° E. with an easterly underlay, the thickest being 16 inches. The only gold which has been obtained is not from these veins however, but from thin irregular leaders in the rotten rock near the surface.

The absence of trachytic rocks up the Matawai Creek is rendered very obvious, by comparing it with the Waiau, which flows direct from the trachytic district of which Castle Rock forms part. The gravel in the Waiau is chiefly composed of a porphyry, consisting of grey felspathic base, with large crystals of hornblende. Half a mile up the river from its junction with the Matawai, it flows over solid ledges of this trachyte porphyry, and although the valley has been well prospected no gold has ever been obtained.

From this circumstance, I think it probable that the trachyte will be found to cut off the auriferous rocks to the south, just as the volcanic agglomerates bound them on the east and west. The reefing district will therefore be limited at Coromandel, to the range of hills that extends from the Matawai on the south to some little distance beyond the Tokatea Peak.

Two bands of the auriferous formation appear to cross this range obliquely, as shown in the accompanying map (No. 4). The first of these extends from Preece's Point (which consists of the decomposed greenstone tufa), through Keevin's Point, Driving Creek, Tokatea, and on to Waikawau Bay, where traces of gold are reported to have been discovered.

The second extends from the Tiki diggings, by the old Wangapoa diggings, to the Haratuhunga Creek, which flows to Kennedy Bay from the south.

At a low estimate this district must be held to include an area of not less than five square miles, but in which gold has only been obtained in notable quantity at the Kapanga.

The following is a recapitulation of the localities where gold has been obtained in this district, and where prospecting has been carried on to a sufficient extent to test the ground.

1. Preece's Point. A low promontory jutting into the harbour,

composed apparently of the same rocks as those in which the auriferous reefs occur. A good section is obtained of this promontory, and shows a great variety of decomposed tufaceous rocks, some of which are full of pyrites, and traversed by leaders of quartz. These have been driven on in several places, but without profitable result.

2. Keevin's Point. The hill has been burrowed in every direction, and very promising-looking reefs struck, but no gold obtained.

3. Kapanga and Driving Creeks. Thoroughly worked for alluvial gold. One well-established lode discovered, and some tributary lodes, which yielded gold near their outcrop, to various companies of miners. This lode has been followed down to a considerable depth only in one instance, and failed from the irregularity in the mode of occurrence of the ore. No tributary lodes or leaders have been explored for by cross cuts at the greatest depths attained.

The existence of barren ground, but still with quartz veins, on the east side of the auriferous belt, has been established by exploration drives and shafts.

4. Tokatea. No defined or steady lode has been discovered in the higher part of the range, the workings being on small irregular leaders in the decomposed greenstone tuff. The existence of the great Tokatea reef at the extreme altitude of the hill, 1,600 feet, indicates that the existence of quartz in the rock has no relation to the existing surface features of the country. These features having been formed by denudation, there is just as much chance of striking a defined lode at a high as at a low level, if due allowance is made for the decomposition of the rock and the local slips and dislocations which affect veins in steep hill sides.

5. Patawau Creek. A limited patch of alluvial gold found in a blind gully, cut into decomposed felspathic slates. No reef has been found although explored for.

6. Matawai Creek. Terrace alluvium of coarse slate and sandstone gravel. Gold in waterworn nuggets mixed with quartz.

7. Tiki. Altitude, 1,200 to 1,800 feet. Decomposed greenstone tufa and blue sandstone and slates, cut by irregular leaders of auriferous quartz.

8. Wangapoa. On top of the northern continuation of the Tiki ridge, at an altitude of 900 feet. No distinct quartz veins, but a fissure with fragments of honeycomb quartz, containing bluish ferruginous (or manganese ?) clay, and leaf gold.

9. Kennedy Bay. Alluvial washings in the bed of a creek leading from near the Wangapoa diggings. No reefs.

10. Gold is also reported to exist on the north side of Mercury Bay, but if so, it must belong to a totally distinct outcrop of the auriferous rocks, probably in N.E. continuation of the Tapu Creek ground.

From notes furnished by Mr. Davis respecting the western part of the Coromandel District, which I had not an opportunity of examining, it appears that a good natural section is obtained at Kiko-waka-reru Bay, showing the trachytic tufas and breccias in their order of superposition, first a tufa, then a breccia, and so on, each bed being from fifteen feet to as many yards in thickness, with a general dip to the E., and a N. and S. strike. These beds are of the most varied colours, red, blue, yellow, and green; they are apparently parallel to, and bedded with, two dykes of doleritic basalt (labradorite, olivine, and augite), which by their superior hardness have resisted the planing action of the sea, and formed the point separating this from Omaru Bay. (Diagram I.) In one place the hard blue breccia (similar to that in Tararu Creek) is overlaid by a softer brownish one, which rests unconformably on its waterworn surface. (Diagrams II. and III.) This is evidently an outlier from a similar bed in Omaru Bay, and which probably at one time covered a large area.

A small island lying off Omaru Bay presents an interesting section. (See Diagram IV.) On the land, or N.E. side, is a dyke of trap basalt intruded through a breccia, which is composed almost entirely of fragments of diorite. On both sides of the breccia is a diorite dyke, each of which dips outwards.

Mr. Davis also reports, that the principal claims on the Tokatea were, at the time of his inspection :—

Erin's Hope Claim, on the Pukututu Creek. The reef runs N.E., with a southerly dip. Some very fine specimens have been taken out from time to time, but the actual yield of gold in bulk of the quartz has not yet been ascertained. The quartz is a hard brown variety with black stains, the roof of the leader a beautifully white tufa with pyrites, and the footwall a brown pyritous tufa. A greyish mullock rests on the footwall.

Peep of Day Claim, on the Kennedy Bay watershed, has a very strong reef, from almost any part of which good prospects are easily obtained. The leader runs N.E., dip W., and consists of a brownish quartz, generally crystalline, and more or less cavernous. The roof is a brown soft tufa, and footwall trachyte tufa partly decomposed.

Tokatea Claim is traversed by two different leaders, the larger one running N. and S., dip W., the other E. and W. This is one of the oldest claims on the field.

Brian Boru Claim, also has two leaders, both running N.N.E.; but while one is vertical the other dips W. Very rich specimens have lately been taken out of this drive.

Harbour View Claim, one of the best on the hill, has been carefully and judiciously opened up, and is now ready for working on a large scale. A great deal of gold has been extracted from both of the two leaders which are intersected in the workings; one of these runs N.N.E. dip W., and the other E. and W.; the former is very regular in its yield of gold, but the latter is patchy, sometimes giving very rich returns and at others containing no trace of gold. The footwall is a diorite tufa, which frequently contains marcasite besides the usual common pyrites.

TAPU CREEK.

This is the next locality south of Coromandel where gold has been found in quantity. Very little progress has been made in this mining district since the date of Captain Hutton's Report, in 1869. Mr. Davis, who has recently examined it, is of opinion that it has been to some extent sacrificed to the superior attractions of the Shortland Field. The number of diggers had fallen from five hundred to fifty, but those that remained were well satisfied with their returns.

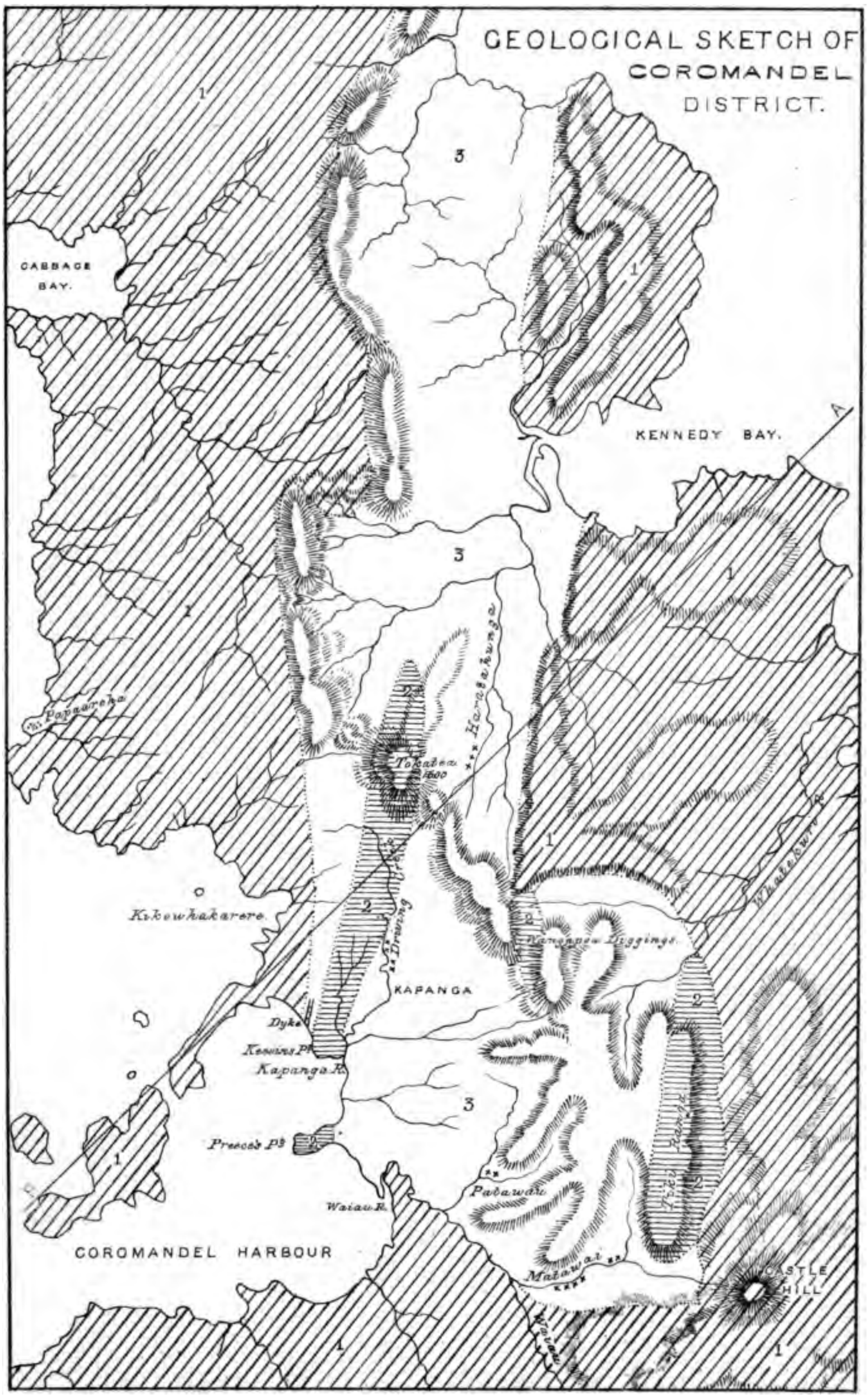
The structure of the district bears a strong resemblance to that of the Matawai Valley, Tapu Creek flowing over green and blue slates, sandstones, and breccias, which rise on the north side of the river to form an isolated mass of hill, about 1,000 feet high, in the decomposed surface rock of which most of the remunerative reefs are situated. No well-defined lodes have been established, the reefs being in the decomposed slates and bands of greenstone porphyry which intersect them with a prevalent N.E. strike. In the slope deposits on this hill rich patches of alluvial gold were obtained when the field was first discovered, some of the nuggets weighing over an ounce.

On the south side of the creek are hills of trachytic agglomerate, which have been thoroughly tested, but, except in a few claims near the junction of the two formations, they were not remunerative. In the same manner the eastern extension of the gold is cut off by trachytic rocks.

In this district therefore we have the auriferous reefs confined to the surface of the older slate and greenstone rocks, which have been laid bare by the denudation of the trachyte breccias.

On this subject Mr. Davis furnishes me with the following notes.

Tapu Creek District furnishes very conclusive evidence of the existence

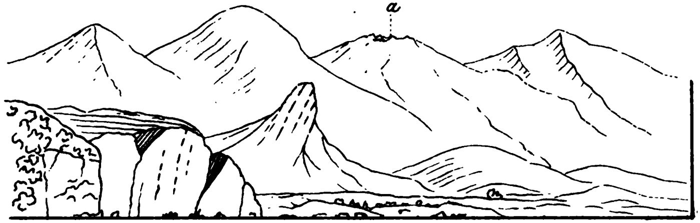


1 *Volcanic agglomerate and trachyte Series*

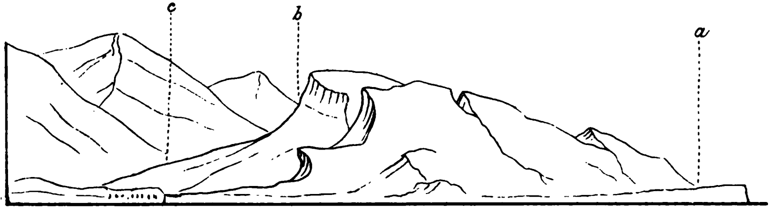
2 *Areas prospected for Reefs.*

3 *Older Slate. Sandstone. and greenstone Tufa Formation.*

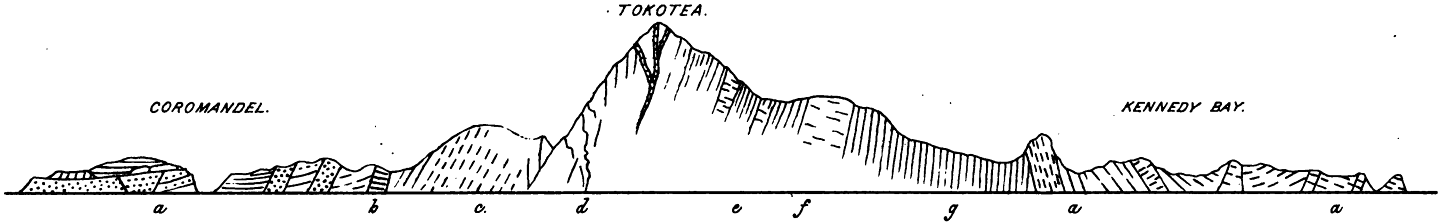
xxx *Alluvial Gold.*



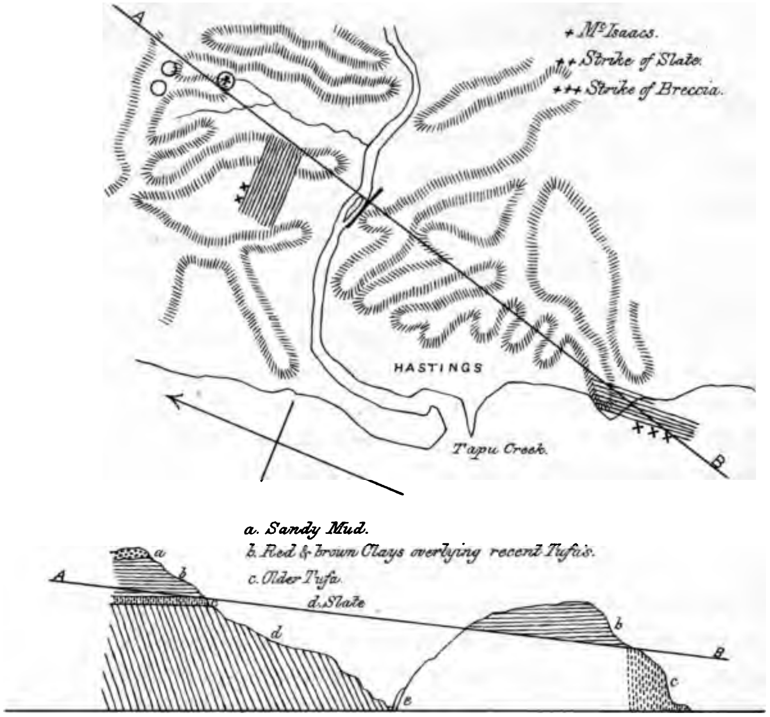
1. S.W. VIEW FROM KENNEDY BAY. a. TOKOTEA HILL.



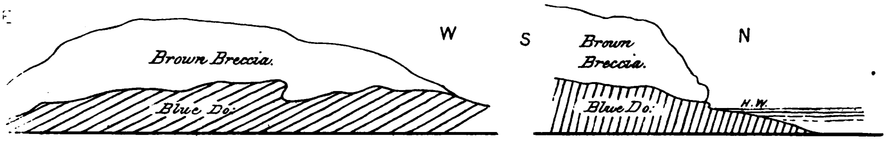
2. N.E. VIEW OF KENNEDY BAY. c. SAW MILL.



3. GENERAL SECTION. *a. Trachyte Series. b. Basaltic Dyke. c. Greenstone Tufa. d. Greenstone Porphyry, with auriferous Veins. e. Sandstones. f. Crystalline Bands. (Dykes.?) g. Felspathic Slates, blue & yellow.*

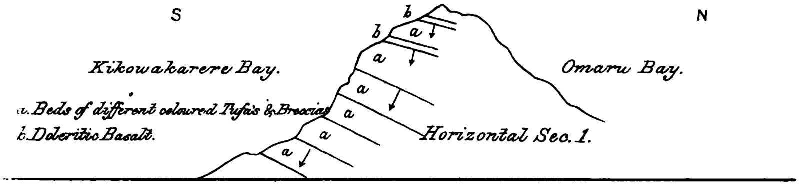


PLAN & SECTION, TAPU CREEK.

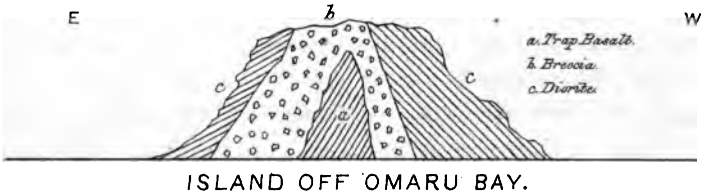


Vertical Sec. 2.

Vertical Sec. 3.



SECTIONS IN KIKOWAKARERE BAY.



ISLAND OFF OMARU BAY.

"of two distinct and two widely separated volcanic formations. Section I. "shows this clearly. It is from the south head of the bay in which "Hastings is situated, to the top of the hill above the Tapu Gold Mining "Company's Claims. The dotted line shows a supposed plane of marine "denudation, subsequent to the deposition of the older trachyte breccia "which lies against the slates, and prior to that of the recent tufas which "rest nearly horizontally on the top of all."

"It would appear as if the stream originally ran more to the N. than "at present, and that it has gradually cut away the tufas, leaving the "slate until it reached the dyke, which has for a time arrested its progress "in a southerly direction, and compelled it to cut a channel in the slate "itself; the blank space in the Section cannot be filled in, as I do not "know what formation exists there; at the same time I see no reason for "supposing that the slate is cut off by the dyke. The slate and volcanic "formations are quite unconformable, the one running N. and S., the "other E. and W. The more recent tufas are nearly horizontal."

OHINEMURI.

Deferring for the present the discussion of the Shortland district, (including the Puriri), which has recently been reported on by Captain Hutton and Mr Davis, I pass the most southern locality in the Colville Peninsula, which has been prospected for gold. The Ohinemuri River is the largest tributary, which the Waiho or Thames receives from the eastward, the two rivers joining about 18 miles, in a straight line, south of Shortland, but about 30 miles by the windings of the stream, which is navigable as far as the Junction. The mountain range, which forms the backbone of the Colville Peninsula, is at this point reduced to a single narrow ridge, broken through by the gorge of the Ohinemuri River. This river drains the eastern watershed of the Peninsula by three principal feeders—one, the Whatakura, rising in the ranges to the north, apparently near the sources of the Kahurangi; a middle branch, which rises close to the sea coast, taking the drainage of a large extent of open level country extending eastward to the edge of a steep cliff that rises abruptly from the sea shore on that side of the Peninsula. The third and largest branch, the Oraki, is fed from the eastern slope of Te Aroha, and the ranges which flank it on that side. These branches join to form the main stream of the Ohinemuri at the gorge, after passing which the stream has a short course of 5 miles through the alluvial deposits of the Thames Valley, receiving only a few insignificant streamlets from the western side of the range. I may remark that this exceptional physical conformation affords a practically level route through the range at this point, the gorge being short and not precipitous, and the greatest elevation in this line, at the source of the middle branch, within 3 miles of Waihi, on the East Coast, being only 370 feet above the sea, with very favourable ground for grading down to Tauranga Harbour.

I recently explored the district (19th to 26th April, 1870), crossing the range north of the gorge to the head waters of the northern branches. In crossing the alluvial flat between the Thames River and the base of the hills, several outlines of dolorite were observed, being the remains of what were once continuous sheets that occupied this part of the valley at a low level. The outer range proved to be formed of dark coloured trachyte tufa, beyond which is a basaltic range, the summit of which is 1,100 feet above the river. This range has broad massive ridges, which continue for six miles, when the formation changes, at a marked dip in the ground, beyond which the ridges become narrow, and the gullies steep. The formation is here a yellowish white, smooth grained, or gritty felspathic rock, intersected by quartz veins, which frequently mark the summits of the ridges. Several of these reefs have been opened at the surface, and consist of sub-crystalline quartz, not unlike that which occurs at the top of the Tokatea Hill at Coromandel. From the highest point of these hills (1,210 feet), at what is called the bare patch, a magnificent view is obtained, especially to the south and east, in which direction the country is quite free from timber, except in the vallies leading from Te Aroha. An abrupt descent, of 500 feet, leads to the valley of the Whatakura, with several principal branches, in some of which a good deal of prospecting had been done along the base of the terraces. The most extensive of these workings, which were all abandoned at the time of my visit, consisted of two tunnels, driven for about 130 feet in a north direction. They both passed through a soft porphyritic rock, decomposed to a white mottled clay, with obscure crystals interspersed. A few small leaders of compact sub-crystalline ferruginous quartz had been cut, but no decided reef found. I was led to understand by one of my party, who had been digging there, that no gold had been obtained from these drives, but that some small specimens found in the adjacent creeks, had led to the under-ground exploration. Small quantities of gold are reported to have been found in several places on the west or right hand side of the Whatakura, but never in any of the creeks on the opposite side. The main stream, which is 30 feet wide, flows on a bed cut in this soft porphyritic rock, but is full of rolled boulders of trachyte and dolerite, derived from the surrounding hill tops. On following down the river for 5 miles, to its junction with the Ohinemuri, in the low level land seen from the top of the mountains, the trachytic lavas are met with, forming wide-spread floes, over which the river runs in a broken rocky bed—falls 30 to 40 feet in height being frequent. The plains are about 4 miles in width, and expand towards the eastward, the soil being everywhere extremely poor, owing to the trachyte being near the surface. The vegetation is chiefly short, wiry manuka, rushes, and straggling ferns. In one part of the plain, a little below the junction of the Whatakura, and almost directly south of the Bare Patch Hill, there is a good deal of quartz, in fragments, strewn on the surface, which I failed to trace to its source, but which appears as if derived from veins in the neighbourhood. Along with these are fragments of quartz, porphyry, and nodules, with large well-developed crystals of quartz. It is, no doubt, the occurrence of these fragments on the surface, and the wide expanse of terraced-plain, recalling, as it does, the surface features of the southern gold fields, that has led to the general belief that alluvial gold will be found in this district. Following up the valley of the middle branch of the Ohinemuri to the eastward, the only rock exposed at the surface is a compact trachyte, sometimes porphyritic, until a low range of hills, 360 feet above the general level of the country, but presenting broken rocky cliffs 500 feet in height to the sea, is reached. The coast is, on the whole, very bold, and in the cliffs between Mataura and Waihi of true trachyte agglomerate, intersected by dykes of trachyte, that give rise to remarkable promontories, enclosing a few sheltered bays, in some of which are small Maori settlements. The upper part of these hills is formed of true rhyolite, or quartzose trachytes, apparently similar to those at Roturoa, in the Lake district, and which, by their disintegration, give rise to extensive beds of felspathic and quartz sands. The only exception observed to the above formation is on the south headland of the first sandy bay north of Waihi, the Maori settlement at the commencement of the long sandy beach that extends to Tauranga. The north headland of this bay is composed of the ordinary agglomerate, containing masses of scoria and basalt in a tufaceous matrix, but the rock at the south headland contains large angular blocks of primary slate and sandstone, and masses of green breccia, so that probably the junction of the agglomerate with the older rocks of the district is not far distant. On the face of the spur above this point a small quartz reef crops out at the surface, and in the gully beyond a soft blue rock is exposed, covered by a wash of rolled fragments of green sandstones and diorite, thus indicating a nearer approach to the character of the formations in the auriferous parts of the peninsula than I had observed in other parts of the district. The deficiency of pyrites, however, which argues against the probability of gold being found in any quantity in any of the places where the ground has been tried. Returning down the river to the westward, through the gorge, heavy deposits of alluvium are found at a considerable elevation above the stream, indicating the higher levels of the former river channels as it cut its way gradually through the barrier of trachyte rock. These drifts contain well rounded boulders, of large size, chiefly fragments of trachyte and chert, intermixed with ferruginous sand, and it has been ascertained that a little gold is irregularly interspersed.

The accompanying map and section represents the opinion I formed of the relative position of the geological formations of this district, from the examination I was able to make, which was very cursory on account of the difficulties raised by the Natives.

The relative positions of the different places alluded to is shown on the map, and the geology is illustrated only by the sections, as follows :—

(*a.*) Alluvial flats of the Thames Valley.

(*b.*) Outliers of vesicular dolorite, like that immediately south of Shortland, forming small hills on the plain.

(*c.*) Trachyte tufas, forming a low range of ferny hills.

(*b**.) Hills of dark coloured lavas, interstratified with softer argillaceous tufas (dolorite ?)

(*d.*) Summit ranges, white tufaceous rock, either gritty or porphyritic, with quartz veins.

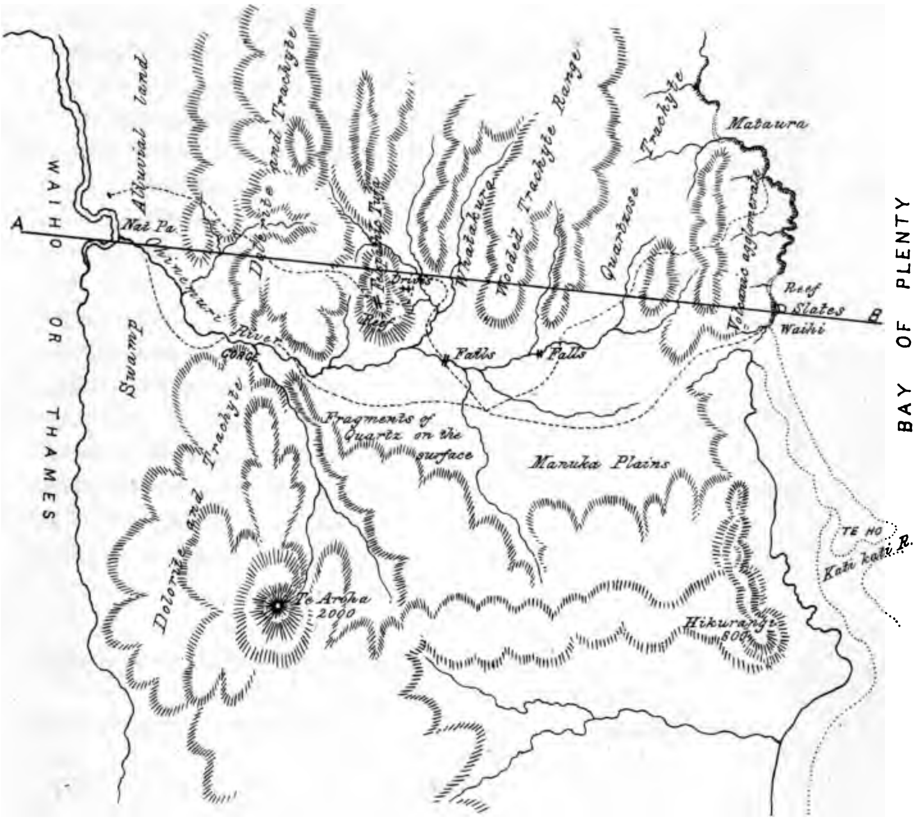
Where these rocks are explored by drives in the valley of the Whatakura, at *d**, the formation is a white porphyry, decomposed to the consistence of pipe-clay, and traversed by leaders of quartz. The sudden alteration in the form of the hills, and the marked change in the mineral composition of the rock, and other circumstances, indicate that *b** is unconformably superimposed on *d*, and that the two formations are distinct. There is a similarity in the character of formation *d* to that of the "country" rock at Shortland, but none of the sections exposed show any of the greenstone tufas, charged with pyrites, which are characteristic of the presence of auriferous veins.

(*e.*) Rhyolite, or quartzose trachyte of the coast range, forming rounded hills with weather-worn bluffs, somewhat resembling the features of a granitic district.

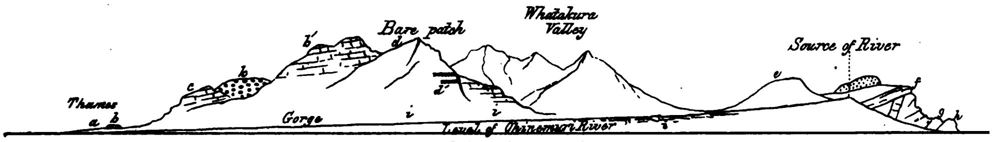
(*f.*) Volcanic agglomerates, intersected by dykes.

(*g.*) Breccia rocks, like those at Tararu.

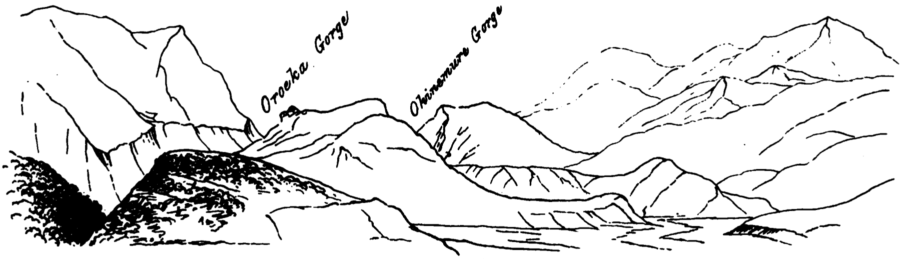
(*h.*) Headland of greenish slates ?



GEOLOGICAL SKETCH OF OHINEMURI DISTRICT.



SECTION on LINE A.B.



OHINEMURI GORGE, LOOKING WEST.

(*i.*) Porphyritic trachyte, in lava floes, that overspread the wide level tract above the gorge.

(*k.*) Deposits of coarse waterworn drift, intermixed with ferruginous sand, skirting the valley of the river immediately below the gorge to the height of 200 feet above the level of the stream. On the surface of this drift are large masses of chert. This section, therefore, appears to indicate that the main range of hills at this place is entirely composed of igneous rocks, with the doubtful exception of the bluff (*h*) near Waihi; and that the formation *d*, whicn represents the auriferous series farther north, must belong to an earlier formation than the volcanic rocks which flank it.

The outline sketch shows the remarkable form which the gorge presents as viewed from the west, being a depression in the range blocked by outliers of the trachyte formation *c*, through which the Ohinemuri and its tributary, the Oeriki, have cut separate gorges, so that they unite on the west side of the range.

ON THE GEOLOGY OF CERTAIN DISTRICTS OF THE NELSON PROVINCE. BY THE LATE E. H. DAVIS.

December, 1870.

INTRODUCTORY SKETCH.

NELSON DISTRICT.

IN making my observations on the mineral belt, which lies to the east of the town of Nelson, three main sections were open to me as indicated in my instructions, viz. :—the valleys of the Maitai and Rhoding Rivers, and the Dun Mountain tramway; these I supplemented by sections run in right lines across the country, so as to connect my main lines of section; these supplementary lines were, from the Maugatapu on the north branch of the Maitai, over the Dun Mountain to the head of the south branch of the same river, thence over the shoulder of the Wooded Peak to the tramway, and so down into the valley of the Rhoding River; from the top of the Dun Mountain down Windtrap Gully to the Maitai; from the Heads of the Pelorus, by Mount Morrison, to the Rhoding River; and lastly, from the Lower Maitai, through Long Gully, up Brook-street Valley, past Jenkins's Coal Mine and Poor Man's Valley, over Richmond Hill to the old Chrome Mine, three miles to the south of Stratford's in Aniseed Valley.

The fundamental rock of the district is the Maitai slate of Hochstetter, which is very much disturbed, and presents a large synclinal curve, having a north-east axis; the south-east flank of the slates rests on a heavy mass of hydromagnesian rocks, which pass gradually into anhydrous olivine; these rocks are probably all products of metamorphism, and not of true eruptive origin, as stated by Hochstetter,* and it is abundantly evident that they owe their present relative elevation to the denudation of the surrounding formations, and not to their own eruption. This mass of serpentinous rock is traversed by dykes of true plutonic rocks, some of which do not even yet reach the surface except in the beds of the streams; the north-west flank rests on a dyke of porphyritic diorite, which is distinct in mineral character from the Dun Mountain metamorphic series. With regard to the time at which the metamorphism of the Dun Mountain group took place, except in a general way that it was subsequent to the Triassic period, we have no direct means of determining, nor yet as to the amount of denudation which has taken place since such metamorphism was effected; these questions can only be solved when an accurate survey of the whole district is accomplished.

Nelson has several times been flattered with delusive promises of great mineral wealth existing in "The Dun Mountain," and even in the face of past experience, many still hold to the opinion that at some time large deposits of copper and chrome ore will be discovered in the immediate vicinity of the old trials; I am afraid I can hold out no such hopes. After carefully examining the whole of the old workings, and entering all that I possibly could, I was convinced that any mining researches in that locality would prove futile, ending only in disappointment and loss.

COPPER.

It is a well known fact that native copper, chalcopyrite, and malachite have been found in the serpentine, on the south-east side of the Wooded Peak (now called Big Twin), and also in Windtrap Gully; these were accompanied by silicates of copper, both dioptase and chrysocolla, which, from their bright blue and green colors, make a great display, even when in very small quantities. These silicates may be traced from one trial working to another in a straight line (of course allowing for the rise and fall of the surface) along the side of the hill, as far as the junction of the south branch of the Maitai and the Windtrap Gully, a distance of nearly two miles; but this must not be construed into an indication that any important quantity of ore exists in the serpentine. I found this line to be parallel to the course of an elvan dyke (one of those before mentioned as not reaching the surface), which is found however, in Rhoding River, and also in the Maitai; in both these places the water has cut through 12 or 14 feet from its top. The section given hereafter shows how completely the serpentine covers it, also the flat top of the dyke; the elvanite is cleaved in flattish wedge-shaped layers, and in the Maitai is slightly bent over to the south; this cleavage is evidently due to great pressure after cooling, and it is a legitimate inference that the same cause would produce a line of fracture in the serpentine, especially if contraction were the motive power, when the serpentine would break over the hard unyielding elvan.

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* *Hochstetter's New Zealand*, p. 58.

In hard compact rocks this would have formed a fissure, and perhaps ultimately a mineral vein, but not so in serpentine, which gives way in a multitude of small cracks and joints, through a given width; in this case it is 4 or 5 feet; these cracks would then become the outlet for water which might find its way up from below, and if this water held copper or iron salts in solution it would inevitably deposit some or all on the serpentine in exceedingly thin films, and as the stone would break at these places it would be almost impossible to tell its real value until analysed. The fact that the water from the serpentine does hold copper in solution is proved, by the floor and stones in one of the old drives being thickly coated with silicate of copper, also by the water from another drive producing all the symptoms of metallic poisoning on both myself and assistant. I am fully convinced that there is a deposit of copper ore somewhere in the district, but the serpentine so completely obliterates all indications of its locality, that it is difficult to come to any conclusion; the only way to search for it is either to go right away from the serpentine, or else to take advantage of the natural cuttings formed by the rivers, to get as near to the base of the serpentine and olivine formation as possible. The place I should choose for a trial would be a point in the Rhoding River bearing S. 50° W. from Coad's Mine, where a gossan may be seen running parallel to and in contact with a hard porphyritic dyke, which presents the same appearance as that previously mentioned; the course is N. and S., dip 88° E.; but, instead of driving towards the Wooded Peak, a southerly direction ought to be taken, so that if possible the point where this dyke intersects another, which occurs about three-quarters of a mile farther up the stream, might be reached. It is true that there are no superficial indications in this direction; but I have before shown that they are valueless in serpentine, and therefore their absence is of no consequence, especially as the presumptive evidence is good. From the tenor of the foregoing remarks it will be apparent that I do not consider that the serpentine rock would pay for further explorations; a few pieces of ore might and probably would be found, but there could be no certainty about it. I do not know of any copper lodes in serpentine which are really worth working, for, although immense returns are obtained one month in such mines, many years may elapse before any further profit is made.

Chrome.

All the chrome workings having fallen in and the men who worked in them dispersed, I could not get any very definite information respecting the manner in which the chrome ore occurred; it appears, however, to have been between the serpentine and hornblende rock when of first rate quality, the commoner being in the serpentine; there is a little still left about the outcrops of the old workings; but I was assured by the present manager to the Company that there was none left underground. The way that both this and the copper occur is very common on the outskirts of a mineral country, and may be taken as a good indication that mineral wealth does exist in the Province, probably near the junction of the true igneous rocks and the palæozoic slates.

Gold.

Until the analysis of the various rocks are completed, it is premature to express any decided opinion on the prospect of payable gold-reefs being found in the immediate neighbourhood of Nelson, but, judging from lithological characters and structure, the Rhoding River rocks are strictly analogous to the auriferous ones of Gympie Creek, specimens of which were presented to the Colonial Museum by Mr. T. R. Hackett. In a report furnished to the Queensland Government, Mr Hackett, in speaking of the auriferous belt. says,* "This belt, or zone, consists of a series of strata, of greenstone shale, and slate rocks, differing in mineral composition and texture, but exclusively of a basic variety of rock." He also states that this belt is skirted by a series of highly metamorphic rock, in which no gold has yet been found, although many reefs have been explored. Copper ores are also found in some of the reefs, and in others the quartz is partly replaced by calcspar, sometimes wholly so; in either case the gold diminishes as the calcspar increases. These extracts irresistibly remind one of the Nelson formations, greenstone and slate, copper ores, metamorphic rocks, and lastly, as if to complete the parallel, in the Maitai all the quartz veins contain calcite in more or less abundance, some of the veins being almost entirely composed of that mineral, while in the Roding they are nearly all pure quartz. The place previously indicated as being worth a trial for copper, also corresponds in almost every particular with Mr Daintree's descriptions of the reefs in Gilbert Ranges Gold Fields.* In speaking of the dykes or elvan courses, he says: "It is at the point of intersection of such rocks that the most mineralization has taken place, quartz reefs abound, and specular iron, copper, and lead ores occur." In the lower part of the belt, which I consider to most nearly correspond with the Gympie Creek formation, I observed three separate springs, the water from which, as it oozed out of the crevices of the slate, had a most intolerable stench of sulphuretted hydrogen ; I would therefore caution prospectors and others not to trust to amalgamation only in testing any quartz from this locality.

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*Geological and Mining Report on the Gympie Creek Gold Fields, 1869.

General Topographical Features.

The tract of country examined in detail, and of which sections to scale are furnished, extends from Nelson in a S.E. direction to the Maungatapu Range, thence in a S.W. direction to the Pelorous watershed, a mile to the S.E. of the Dun Mountain, thence to Wairoa Gorge in a S.W. direction, and from thence northwards to the sea; the shore forming the N.W. boundary. The area surveyed is close upon a 100 square miles, the greater part of which consists of a rugged mountainous country, very difficult to work in, sometimes a whole day being required for a mile of ground. The range of which the Dun Mountain forms a part, and which divides this block from the Pelorous watershed, consists of lofty mountains varying from 2,500 to 5,000 feet in height, and is for the most part clear of bush on the side facing the North, except in some of the deeper gullies where the usual Black Birch bush flourishes luxuriantly.

The range immediately to the North of this presents a great contrast. It attains its maximum height—4,000 feet, in Wooded Peak, which, as its name implies, is covered with dense bush ; this bush, however, is only a strip running in a N.E. direction from near Stratford's in Aniseed Valley up the general course of the Roding River, over half the Wooded Peak and across the Maitai, when it spreads out like a fan. The growth of the forest trees seems dependent on the lime derived from the calcareous slates and the limestone, as their limit seems to be confined to a short distance on either side of that formation. Any bush that grows on the sandstone and upper slates is stunted and local, so that the term "bare" may be justly applied to those districts which are of these two formations. The Magnesian rocks too are almost destitute of trees, except manuka scrub here and there, and the bush in the gullies before alluded to. From some cause or another the manuka is nearly all dead, giving a false aspect to the country when seen from a distance, as standing close together and being quite white, it has the appearance of out-croppings of limestone. In front of that, to the North of the belt of bush the hills are all bare right down to the coast, or the alluvial land, as the case may be.

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* Report on the Gilbert Ranges Gold Fields, by R. Daintree, Government Geologist, Northern Queensland, 1869.

RIVER SYSTEM OF THE DISTRICT.

The district is drained by two principal rivers, viz: the Roding and the Maitai; the latter, although the shorter of the two, exercises a greater influence on the country. It rises on the side of the Maungatapu, and taking a north-westerly course reaches the sea close by the town of Nelson,—7 or 8 miles in a direct line from its source, the actual course of the stream being much longer from its windings. Its principal tributaries are the South branch of the Maitai, running from the saddle between the Dun Mountain and the Roding River to Dwyer's on the main stream, a distance of a little over 4 miles; a creek on the east side nearly opposite Long Gully, and the Brook-street stream, which rises under the Wairoa saddle, and after a course of a little over 4 miles falls into the Maitai in Nelson.

The other river, the Roding, rises on the north side of the saddle at the old Chrome Mines, and after running comparatively straight for about 2 miles in a N.W. direction turns abruptly round to the S.E., taking its course along the strike of the rocks, then becoming excessively gorgey and difficult to travel in. It falls into the Wairoa about 2½ miles above the bridge, the distance in a straight line from its source being nearly 13 miles. Its tributaries are all on the south side except one small stream from Wairoa saddle. The principal ones are the Hackett and Serpentine Rivers; the former of which is quite as large as the Roding itself, and runs about 3 miles back in a S.W. direction. The Roding river and Aniseed Valley are separated from the Waimea plain by the range of Richmond Hills. These hills are abrupt and steep, having only one continuous slope on the southern side, but on the Richmond side the slope is more gradual and is relieved by secondary hills and spurs, thus placing the crest of the hill considerably nearer to the South than the centre when compared with the base.

SUPERFICIAL DEPOSITS.

The superficial deposits may be divided into three classes:

(*a*.) Alluvial.

(*b.*) River deposits of gravel.

(*c.*) Slope deposits.

(*a.*) ALLUVIAL DEPOSITS.

These are of very considerable extent, as in the valley of the Waimea, which extends from the Wairoa along the base of Richmond Hills to the rising ground on the N.E. of Stoke, and is bounded only by the sea on the W. Besides this the town of Nelson is built on alluvial soil which also extends up the Brook-street for a short distance, and up the Maitai; a few patches are also found up the Roding River, but they are small and not of much importance.

(*b.*) RIVER DEPOSITS OF GRAVEL.

The Port Hills are covered to a considerable thickness with coarse drift of thoroughly rounded stones and sand, which also seems to have filled up a valley which at one time came out between the Port and Nelson. A good section of the drift may be seen here. The same class of drift may be seen in Brook-street Valley, and near Jenkins's Coal Mine; it also forms a rising ground between Richmond and Wairoa Bridge. From the arrangement of the stones these deposits must have been formed, as a whole, by the action of rapid rivers of considerable volume; in some places the Port Hills, however, show no such arrangement.

(*c.*) SLOPE DEPOSITS.

These are necessarily plentiful in such a district as that around Nelson, but only one is worth mentioning. That lies to the north and west of the Dun Mountain, and near its base is consolidated into a regular conglomerate. It will be more convenient to describe it in detail when treating of the sections.

NARRATIVE OF EXPLORATIONS.

Leaving Wellington on the 26th September, it was mid-day on the 28th before a start could be made for the Dun Mountain. From then till the 4th October, I was engaged on the Dun Mountain, south side of the Wooded Peak and the Maitai. Two days were devoted to the Dun Mountain tramway section, and in completing the examination of the Wooded Peak; three days to the Roding River; one to the Serpentine; two to Richmond Hills and the Waimea; two to Brook-street and the Lower Maitai; two to the Port series; and one to the hills round Richardson's Run; this, with a few days required for labelling and packing specimens, occupied four weeks.

The opportunities for observation were very good, and except in a few places, all important junctions can be made out. The Dun Mountain is one of the exceptions; the slope deposits are so thick and continuous as to offer very serious obstacles in the way of tracing boundaries of formations. The Maitai Valley is very useful as it cuts across nearly all the strata, and it is easy to get the true dip and strike at once without having to take oblique angles, and especially the two branches above Dwyer's give very fine sections. The Dun Mountain Tramway is also of very great use, but the old mines are too dilapidated to offer any assistance, and, moreover, they are entirely in serpentine.

A very fine natural section is exposed in a cleft or chasm a little to the south of the Mine Saddle. The first two or three miles of the Roding were profitably examined, as they give a section parallel to No. 1, but nearly 1,000 feet lower. It is very laborious examining these steep hill sides, but the results are so satisfactory that they well repay the trouble expended in obtaining them.

GEOLOGICAL FORMATIONS.

The formations met with in the district under consideration may be divided into five groups, viz. :—

(*a.*) Magnesian rocks.
(*b.*) Limestone and calcareous slate.
(*c.*) Maitai slates, red and green, interbedded with sandstone.
(*d.*) Port Hills series.
(*e.*) Intruded plutonic rocks.

All these may be sub-divided into several varieties of texture, mode of occurrence, bedding, colour, &c.

(*a.*) MAGNESIAN ROCKS.

The Magnesian Rocks, as far as ascertained by actual survey, cover an area of nearly five square miles; by inference they may be safely assumed to occupy the whole of the tract between the limit marked by Section II. on the map, and the Serpentine River, but as this is only an hypothesis, the space is left uncoloured.

This group may be divided into three classes—the terminals being serpentine on the one hand, and olivine on the other. Between these two there is a third class, partially hydrated, and containing more iron and lime than either of the terminals, but still belonging to the same group.

OLIVINE.

The Olivine, or anhydrous silicate of magnesia,* actually constituted a very small proportion of the group, it being confined almost entirely to the plateau on the top of the Dun Mountain; the total area will be, perhaps, half a square mile. At first sight it appears to be much more extensive, but this is due to the peculiar nature of the slope deposit, large blocks, of many tons weight, lying here and there, apparently *in situ*, and requiring a close scrutiny to prove that they are loose. The whole of the north-west and north sides of the mountain are covered with this deposit, which has a great tendency to cement itself together into a conglomerate. An analysis, published in the Jurors' Reports on the New Zealand Exhibition, 1865, p. 411, is reprinted in the Laboratory Report for 1871, for comparison with other analyses there published for the first time. As is not uncommon with olivine, chrome is scattered throughout the mass in minute grains, sometimes more, sometimes less, but generally from 1 to 2 per cent. Olivine also occurs on the hills behind Everett's old mine, as I found a loose piece quite angular, but I could not discover any *in situ.*

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*This rock was called Dunite by Hochstetter, but as Olivine rocks, although rare, are not peculiar to New Zealand, much less to the Dun Mountain, and as the term does not carry any meaning beyond locality, I think that either Olivine rock, or one of the Northern Hemisphere names, is preferable.

SERPENTINE.

Serpentine, or hydrated silicate of magnesia. This class occupies more than two-thirds of the total area of the whole group, and is of very considerable importance in the economy of the district. Its limits are most rigidly defined by the almost total absence of arborescent vegetation, and the flat tops of the hills. The Serpentine, as a rule, is of a poor variety, generally of a dark green, almost black, colour, (appearing lighter by transmitted light), translucent at the edges, and rather brittle; it is very much dislocated and broken into irregular chonchoidal fragments, apparently by the intrusion of dykes at different times.

CHROMITE.

Chromite, a very general accessory of serpentine, is developed in considerable quantities, more especially near the junction of the hornblende rock, at the south end of the Wooded Peak Range; and a few years ago a quantity was extracted by a London Company, but it was found to be impossible to compete with the mines which at present supply the market, and which have the advantage of being near the consumers, and also of having cheap labour. The total consumption of chromite in Great Britain does not exceed 2,000 tons per annum, the whole of which could be supplied by any one of the three principal mines, viz.:—Fünchal, in Norway; the Orkney Islands; and Baltimore, U.S.; moreover, with the slightest increase of price, many places in Europe, at present considered useless, would be energetically worked, until the price was again reduced.

COPPER.

Native Copper has been found at different times, principally on the south or Dun Mountain side of the Wooded Peak, and notably in a drive in Windtrap Gully; dripstone chrysocolla, and cuprite, also occur in the serpentine. The two first are most common in cracks and joints in the serpentine, in thin fibres, of an almost imponderable value. These indications occur in an almost straight line for nearly two miles, and have been most thoroughly explored. I visited nineteen different trials, and am not sure that I did not miss some after all. In the preliminary part of this report I have discussed the question of the probability of payable ore being found, so need not repeat my arguments here.

IRON.

Iron ores also occur, principally as hematite and limonite. The serpentine is particularly interesting to the mineralogist, from the great number of minerals which it contains, dermatin occurring in thin faces, with smooth polished surfaces, antigorite being found here and there, a mineral closely resembling asbestos also occurs with serpentine, &c., &c.

EARTHY MINERALS.

In addition to these the following occur as veins of more or less permanence: white nephrite, albite, hornblende, diallage, and scapolite, occur in isolated patches, of considerable size. The map shows the outline of the serpentine, as far as ascertained; between it and the Olivine Rock of the Dun Mountain there is a belt about 250 yards wide, which is occupied by

HYDRATED ROCKS.

Partly hydrated rocks, containing more iron and lime than either olivine or serpentine. The analysis of most of these rocks is given elsewhere.* Bronzite and hypersthene also occur on the saddle at the Chrome Mines, and then comes the hornblende rock. It is not possible to make out any distinct boundaries for these different rocks, as they are mixed up, in inextricable confusion, with intruded felstones, which stand up like pillars, having resisted the action of the weather better than the softer rocks surrounding them.

(*b.*) LIMESTONES AND CALCAREOUS SLATES.

These are grouped together, because from the fact of the calcareous slates both overlying and underlying the limestone at the same place, they must have been deposited in a continuous manner, and possibly represent a gradual subsidence and subsequent upheaval of the land. It is a matter of great regret that a friction breccia exists between this group and the last, as the actual junction between the two is thereby destroyed, and we cannot tell in what state the strata, which actually rested on the serpentine, were in.

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* Laboratory Report, 1871.

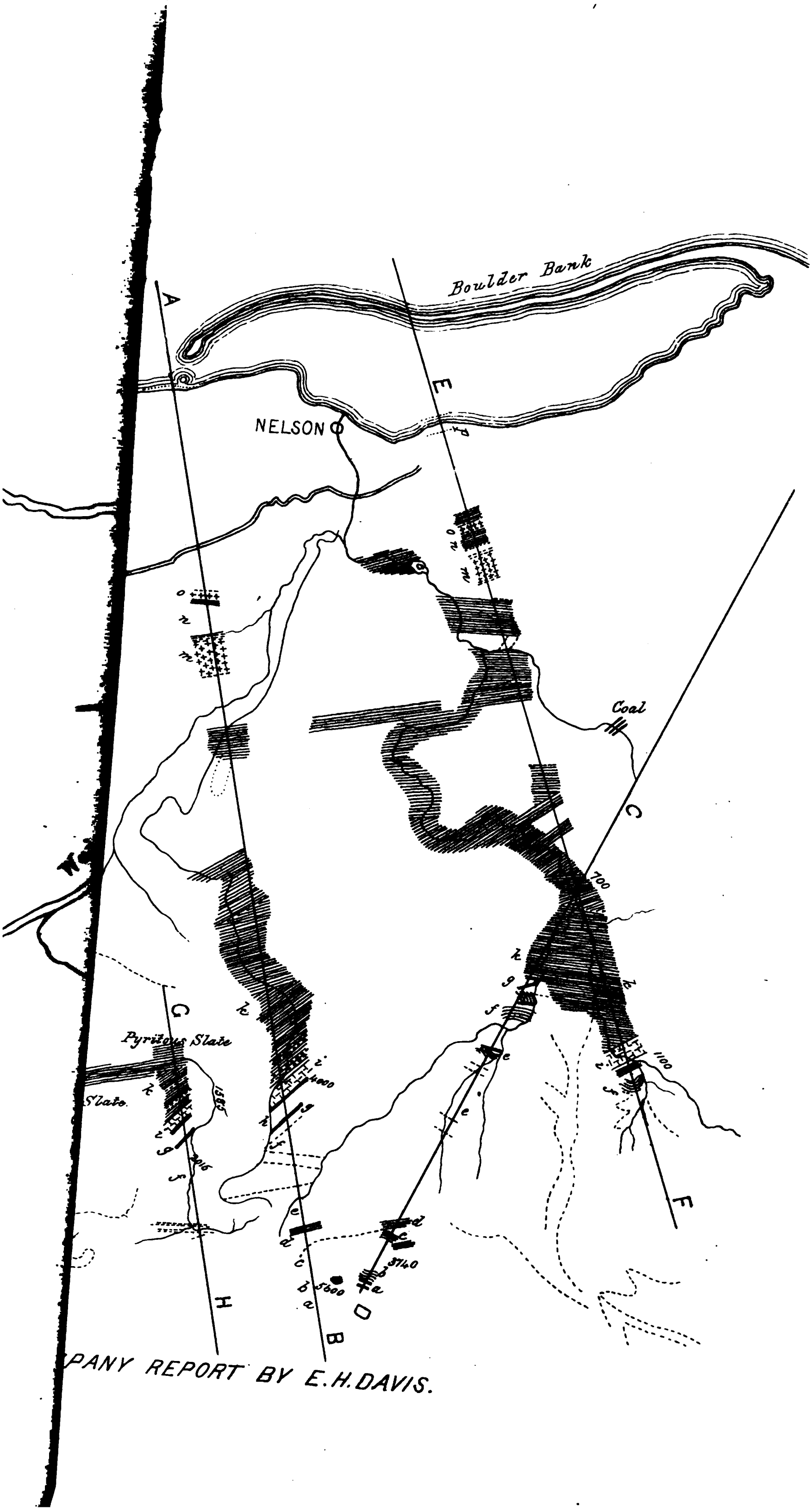
The general strike is north and south, with a westerly dip. The calcareous slates are bands or slabs of limestone, separated from each other by thin laminæ of green slate. I could not detect any traces of fossils in either. The limestone is a blueish white, compact stone, with a smooth fracture, and seems very much contorted in one place. The only traces of fossils were some indistinct coral fragments; one piece shows dendritic markings, but not of any import. Some beds of the limestone have cubical pyrites disseminated through the mass. The area occupied by the limestone, and ascertained by actual survey, is very limited, as shown on the map. The reasons why the limestone could not be connected from one place to another are, that it forms high cliffs, rendering considerable detours necessary to get round them, and that the whole is dense bush, and a great deal of time would have been expended for very inadequate results. This group attains its maximum thickness on the Maungatapu, where it is fully 2,000 feet; on the Dun Mountain Tramway it is about 1,000 feet, and in the Roding River increases again; but in this instance a band of hard cherty slates intervenes between the upper strata of calcareous slate. Both in the Maungatapu and in the Roding River the highest beds are yielding calcareous tufas in considerable quantities. Crystallized calcite is common to all these localities. On the Serpentine River the limestone is much thinner than in any other place, and the calcareous slates are wanting. It will be observed that this group is not represented at all on the line, Section II., except by calcareous slates.

(c.) RED AND GREEN MAITAI SLATES, INTERBEDDED WITH SANDSTONE.

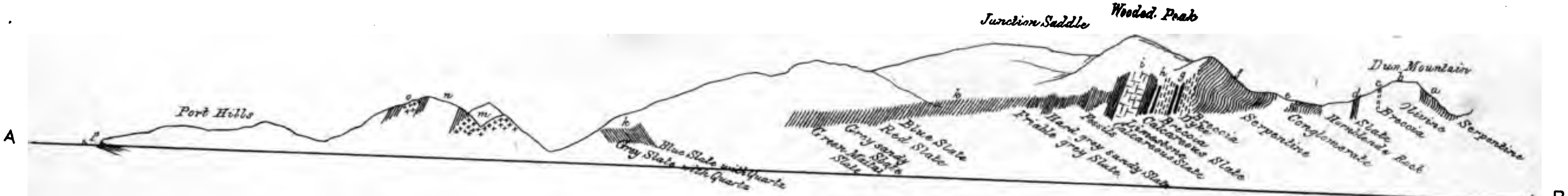
A glance at the map will show that these slates cover by far the principal part of the area examined, occupying not less than 42 square miles. The general strike is N.E. by N., varying from N. 10° E. to N. 40° E.; the dips, as shown in the section, indicate a synclinal curve of considerable importance in the structure of the country. These slates are generally unfossiliferous; one bed of hard grey tough slate, a short distance from the limestone, and, consequently, very low in the series, contains a few fossils, first discovered by Dr. Hector on the Dun Mountain Tramway in 1866, chiefly *Inoceramus* and immediately above this is a bed full of Annellid tracks; about 100 feet above there is another *Inoceramus* bed. Just above Dwyers', on the Maungatapu Road, a few casts were found in a dark blue fissile slate, a cast of part of a cephalopod, annellid tracks, &c. As is usual in slate formations, the dip and strike varies a few degrees every 20 or 30 yards, either up or down, but not sufficiently so to really affect the geology of the formation, the cause being that one bed has yielded more easily to pressure than another, and so became bent and twisted. In one place on the Dun Mountain Tramway the same bed may be seen, dipping E., at the top of a cutting, then becoming vertical, and finally resuming a westerly dip parallel to its fellows. The sandstones are interbedded with the slates sometimes as thin irregular patches, at others forming distinct strata of itself, occasionally of considerable thickness. The physical characters of the group vary considerably, from a loose friable kind, which crumbles into small parallelopodons to a hard cherty slate, almost like flint. I believe Hochstetter confined the term Maitai Slate to the blue and green slates as developed in the Upper Maitai, but it is more convenient to extend the sense of the term, so as to include the whole group between the limestone and the Brook-street igneous rocks, as the whole of the strata included in that area are conformable to one another, and evidently belong to the same geological period, although they are scarcely recognisable in places, from the amount of alteration they have undergone, and might almost be mistaken for regular igneous rocks. These occur notably in the Maungatapu, Lower Maitai, Aniseed Valley, and Roding River. Fissile slate occurs at a place on the Roding River, marked on the map, but not of very good quality. There is also a place on the same river marked sulphuretted hydrogen, where there are three little runlets, two on the north side, and one on the south side of the stream, which are so thoroughly impregnated with sulphuretted hydrogen ; that they may be detected some distance off by the smell, if the day is calm. A white precipitate marks the different points from which the water issues from the blueish green slates. Quartz veins occur in the various localities, and are marked on the map, as mentioned in the former notice of this report. Those in the Maitai Valley are mostly calcareous, whilst those in the Roding Valley are almost pure quartz.

(*d.*) PORT HILLS SERIES.

This group attains its maximum development close behind the port, and consists of yellow and white sandstone, and marl, with a north-east strike and very flat dip to the E. As before mentioned, it is thickly covered by drift ; the beds close to the high water mark are very full of quite recent species of fossils ; these beds extend along the coast for a considerable distance, and do not appear to have been very much disturbed or contorted. It is impossible to get any very satisfactory idea of their thickness, as they extend out to sea, beyond low water mark. I



PANY REPORT BY E.H.DAVIS.



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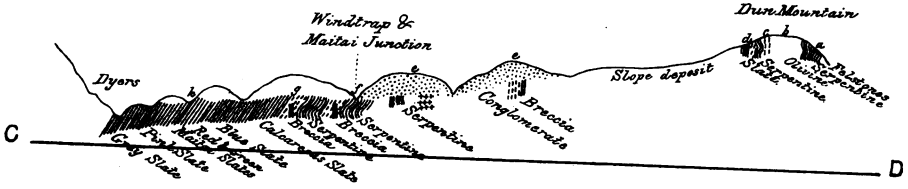
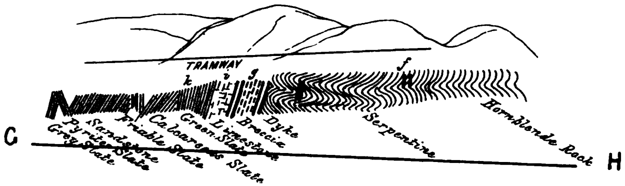


Sec. II



Sec. 4

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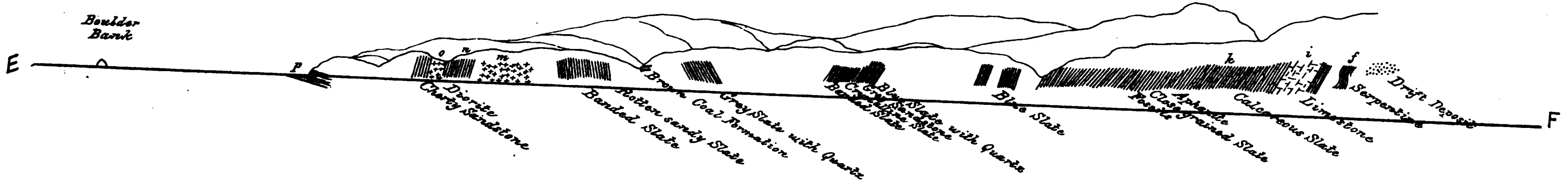

Sec. III

GEOLOGICAL SECTIONS OF DUN MOUNTAIN DISTRICT BY E.H. DAVIS.

must confess that I cannot quite make out a continuation of their formation to Jenkins' Coal Mine, in Ennerglyn, as Hochstetter does, the bed in the latter locality being an isolated patch resting on the slates; the other localities, marked Brown Coal, are also isolated patches, quite unconformable with the slates.

(e.) INTRUDED PLUTONIC ROCKS.

This group is one which exercises very great influence on the physical geological structure of the country, and also on the prospects of mineral wealth being found. It might be divided into basic and acidic, but such a distinction is of no particular use in a report of this nature, and it is more convenient to take the various rocks as they occur in nature.

FELSTONES.

The first, then, will be the white and grey felstones of the Dun Mountain and Serpentine River, which occur in connection with the Magnesian rocks of Group *a*. These felstones cannot fail to attract the attention of anyone visiting the Dun Mountain the moment they reach the summit of the saddle by the old Chrome Mines; they stand up, in isolated patches, here and there, 15 to 25 feet above the level of the surrounding rocks. They occur, also, on the Pelorous side of the Dun Mountain, and also on the saddles at the north end of the mountain. They generally seem to be in pairs, as if there were two belts surrounding the olivine formation. Felstones are generally products of metamorphism; but, in the absence of any proof that these were formed in that way, it is better to class them with the igneous rocks. They have a sharp ring, almost like phonolite, when struck with a hammer; are very tough, and break with a smooth conchoidal fracture, with sharp cutting edges, H. 6·5, G. 2·75.

SYENITE.

A fine grained syenite occurs in the tramway coming up through the serpentine. It is not shown in Section I, as I have no data for fixing its precise locality on that line, and it does not occur in the Roding River section. A melaphyre dyke crops up on the line of Sections I and IV. On the tramway it is accompanied by a friction breccia of considerable thickness. On both sides of it, this rock has a hard splintery fracture and is of an olive green colour, varying to black; the strike is nearly parallel to the limestone. The breccia is especially interesting being composed of slate, red hematite, olivine, syenite, and serpentine; it does not appear to have been disturbed after once being consolidated, although there is another dyke on the other side of it. This dyke is a green rock with crystals of pyroxene in it, and is in actual contact with the calcareous slate; both of these dykes appear in the Roding River Section.

ELVAN DYKES.

Two very important elvan dykes appear in the Roding River, they are true felspar-porphyries, and would not be visible at all if the stream had not cut such a deep gully, as they only appear for about 10 or 12 feet above the water, and do not reach the surface any where on the hills; the serpentine resting on them with a thickness of at least 1,000 feet.

In the preliminary section of this report I gave an account of their mode of occurrence, so need not repeat it here, but I omitted to state that these dykes are not accompanied by any friction breccia at all. Granular dykes which occur in the Maitai branch, but at a little lower level have, on the contrary, a very hard breccia in connection with them.

BROOK-STREET IGNEOUS ROCKS.

The Brook-street series of igneous rocks is of considerable magnitude, the total width being upwards of 2,000 feet; the stone is various in texture, in some places being a pyroxene-porphyry, and others a simple diorite, also brecciated, and here and there amygdaloidal. The slates in its immediate vicinity are very much altered and indurated, and almost unrecognisable as part of the Maitai series; there are two bands of diorite, one very much larger than the other, as shown in the Map. They are separated by a reddish brown slate, which breaks into rhombohedrons, giving evidence of the action of heat; the diorites either terminate a short distance to the N. of Ennerglyn; or else, they have been degraded and covered up with slope deposit. I could not find any trace of them to the south of the Coal out-crop, except perhaps on the side of the hills between Stoke and Richmond, where the rocks are very much indurated, as if there had been an intruded dyke near, but I could not find the dyke itself. In a northerly direction they continue to Wakapuwaka, when they are accompanied by a white freestone and also syenites.

RECAPITULATION.

It thus appears that we have syenites at Wakapuwaka, on the Dun Mountain Tramway, and on the Saddle at the Mines; of these, the last is the finest grained, and that at Wakapuwaka, the coarsest; Felstones at the Dun Mountain, the Serpentine River, and Wakapuwaka; Melaphyre in the Tramway section; Elvanite in the Roding and Maitai Rivers; and Diorites on the Tramway, in Brook-street Valley, and at Wakapuwaka. There are no volcanic rocks that I could find. Pumice stone is said to occur near Happy Valley, but I did not see any trace of it in the streams, and without a guide we could not find the precise locality in the bush.

If we consider the Maitai slates as Triassic, and the limestone as belonging to the same period, we have no Middle or Upper Mesozoic formations in the district; the most recent deposit being a rough conglomerate, which commences in the valley between the Dun Mountain and the Wooded Peak, and passing over the Windtrap Gully continues with slight breaks, as far as the Maungatapu; this conglomerate consists principally of hornblende rock, hypersthene, dunite, and felstone, with a little breccia, and is evidently derived from the degradation of the surrounding country; in some places it is very strongly cemented together and forms high cliffs on each side of the spur between the S. Maitai and Windtrap Gully; the total area covered is not large, and probably, never was very much greater, although the thickness at one time may have been very considerable; I see no reason to suppose that the watershed, at the time of its deposition, had a greatly different direction from the present one, viz., N. and S.

The next formation to this, is, I believe, the so called Dunite, which I consider to have been the last rock of the series to be intruded, and my reasons are—first, that coming out from beneath the conglomerate is a true breccia, containing felstone, slate, serpentine, and hornblende rock, but which does not appear to contain dunite: second, the dunite is almost entirely surrounded by a friction breccia, which contains horneblende rock, serpentine and slate. The slates and serpentine also stand at very high angles, and just behind the old Mine House the slate is thrown for nearly 300 feet. The area actually occupied by the dunite is very small, and I think that its importance has hitherto been greatly exaggerated; the influence it exercises on the surrounding formations is practically nothing, either for good or evil; and the fact of its forming the centre of a mountain, is no evidence that it ever reached the surface, or even near to the surface when first intruded. The dunite contains chrome in variable quantities disseminated through the mass, and also some hypersthene near its edges; the line of demarkation being very indistinct.

Serpentine covers a very large area of country, and appears to come next to the dunite in age; it rests on the slate and is accompanied by various bands of conglomerate breccia, diallage, and other igneous rocks; it is of a very inferior quality and could not be turned to any useful purpose.

Maitai slates are of every conceivable variety of color, red, green, blue, and grey. They present a well marked synclinal curve, which extends from the Wooded Peak to close behind Nelson Town.

SPECIAL DETAILS.

DESCRIPTIONS OF SECTIONS.—SECTION No. 1.

Commencing at the right hand, is from the east side of the Dun Mountain, down the Tramway, and through the Brook-street and Port Hills. The first rock (*a*) is a serpentine slate, passing into serpentine (Sp. No. 28), which is succeeded by olivine (*b*) in considerable mass (Sp. 145), which has no particular dip or strike, seeming to be a mass which has escaped the general hydration of the serpentine. This is succeeded by a rough breccia (*c*) (No. 23), which runs E. 20° N., that is, that the exposed ridge has that direction; the dip I cannot make out at all. It is just possible that this is really a slope breccia, and does not actually intervene between the olivine and serpentine. The serpentine occupies a space of about 1,000 feet (horizontal), when a thin band of slate occurs, running north-east, and with a westerly dip. These slates are similar to those found at Richmond Hills (No. 92), more properly they would be called slaty sandstones. Passing over these, we come upon a confused mass of felstone (*e*), bronzite, anthophyllite, syenite, and hornblende rocks, about 1,500 feet thick, the latter one abutting on the serpentine. The line of junction seems, on the whole, to be nearly vertical; if there is an inclination at all it is to the west. The main body of serpentine which succeeds this has a total thickness of nearly 4,000 feet; a syenite band occurs, but, as before mentioned, I cannot fix its locality, and therefore it is not marked on the section. The conglomerate (*f*) (17), consists of hornblende, serpentine, olivine, and some other rocks, connected together by a white earthy substance resembling bole, and a grey earthy cement. Although I have shown it as if interbedded, I believe that it will, at some future time, be proved to rest in a hollow in the serpentine, and that it is really the same as the conglomerate between Windtrap and Maitai. A slip in the serpentine would account for the serpentine overlying it and, moreover, it does not appear in the lower section (No. 4). A breccia (*g*) follows the serpentine, caused by the intrusion of a melaphyre dyke of considerable weight; this breccia, as before described, contains slate, red hematite, olivine, sandstone, and serpentine. The strike of the dyke is north and south. There is another dyke parallel to this, and also dipping westwards, which is not accompanied by a breccia, the calcareous slates (*i*) resting immediately on it on the west side, and the breccia on the eastern side, evidently belonging to the melaphyre dyke. This little group, 1,290 feet thick, quite shuts off all the magnesian rocks which are underneath it from the stratified ones above. Calcareous slates are the lowest sedimentary rocks still retaining their original characters. They, as well as the limestone and calcareous slates which lie on it, dip W. 76°. Their strike is not conformable to that of the slates which follow, and the limestone runs out before reaching the Maitai River. The base of the Maitai slate formation rests on the calcareous slate; the amount of dip and the strike vary considerably, but not more so than is usual in slate deposits; the various dips are shown on the section, which is to scale, and the strike is shown on the map. The fossil beds are all marked. The order of succession is as follows: friable slate; hard grey slate, containing fossils; light grey soft slates, rich in annellid trails and casts; friable slates, falling into small rhombohedrons; grey slate (93); smooth grey banded slate, with sandstone interbedded (93); hard grey banded slate, with sharp hackly fracture, cleaves into thick slabs parallel to the original bedding, no argillaceous odour when moistened (103); red smooth semi-fissile slate, soft and greasy feel, streak red, rather prone to decompose (25); grey, slightly fissile slate, with sub-conchoidal surface, cross fracture slate, intimately mixed with sandstone, feels smooth, streak white, and rather harder than the last (96); red slate, with a grey streak, forming very thin bands in an open, fine-grained, and white mottled sandstone (97); green compact slate, slightly argillaceous odour, cross fracture, hackly, with very sharp edges (98); grey green slate and sandstone interbedded, roughly cleaved at about 45° to the original stratification (62); cherty slate, with quartz and calcite, decomposes with a white argillaceous substance on the surface (67). All these dip W., generally, about 60° to 65°; but following on the line of section for about a mile, nothing but broken dislocated slate is found till Brook-street Valley is reached, when blue and grey slates, with quartz, having the same strike as the others, but dipping E. 60° are met with. These rest on the Brook Valley diorite (*m*), which again has grey slaty sandstones (*n*) resting on it on the north-west side, then there is the second smaller belt of diorite (*o*), and after that the drift (*p*) covers everything to the cliffs at the Port, where the tertiaries are exposed.

SECTION NO. 2.

Runs from north peak of Dun Mountain to Dwyers'. Direction 15° W. of N. magnetic.

Commencing, as before, in the valley on the south of the Dun Mountain, and taking a pillar of felstone as a starting point, the section is as follows:—

Hard grey felstone (*a*), like that in Section I. (26); serpentinous slate then follows, dipping 60° W., and then olivine (*b*); the olivine on this side is very rich in chromite, and possibly chrome ore, in quantity, might be found between it and the serpentine. On the north side the olivine shades off into a hard black, basaltic-looking rock (*c*), which contains olivine in individual crystals; on this, in one or two places, is a serpentinous slate, then serpentine, and after, a gap, covered with debris grey sandy slate (*d*) is found, running N.E., dip unknown; there is then a long interval, covered with slope deposit, principally serpentine and olivine, till, near the top of the Windtrap Gully, the conglomerate (*e*) commences, and, were it not for the aid afforded by the stream, it would be impossible to see anything else for some distance; as it is, however, I was able to make out a dyke, with a friction breccia on one side of it, as shown, also a breccia composed of elvanite, serpentine, and slate, and then the serpentine (*f*), which is cut by an elvan dyke, running N.E., which does not reach through it. At Windtrap and Maitai Junction the serpentine also occurs, and continues down the stream for about 150 yards; it is then interrupted by a breccia (*g*) (55), caused by the intrusion of an igneous dyke which runs in a N.W. direction (56); this dyke is granitic, containing mica, felspar, and quartz. The serpentine then resumes its course for a short distance, and is again finally cut off by a dyke of elvanite, which, in this case, is accompanied by a breccia; it runs N. 15° E., dipping S.E., and form the limits of the igneous and metamorphic rocks in that direction. We now enter on the calcareous slates (*k*), which in this place strike N. 40° E., and dip 76° W.; these are, perhaps, 200 feet in thickness, and then blue, pink, and green slates, the latter carrying numerous veins of calcite. Just before reaching Dwyers', grey slate comes in. I noticed no traces of fossils anywhere on this line; the average dip is 70° W., and the strike N.E.

SECTION NO. 3.

From the bridge on the New Maungatapu Road, to the sea a mile north of Nelson. Direction north-west.

This section is almost parallel to No 1, and really is the same, except that it begins higher up in the series, only just touching sufficient of the serpentine to show the absence of the two dykes, and their attendant breccias between it and the sedimentary rocks.

The drift deposit marked as preceding the serpentine, is illustrated by various specimens marked 57, which on examination correspond to the rocks found *in situ* on Maitai Saddle. The boulders are of immense size, and do not appear to be water-worn (in the proper acceptation of the term), simple weathering appearing to be the only influence that has acted on them. The serpentine needs no comment, it is the same as the Wooded Peak stone, but is, if anything, not so much dislocated; this is succeeded by calcareous slates about 70 feet in thickness, these are closely followed by the limestone which here attains nearly double the development it does on the Dun Mountain Tramway. The calcareous slates which overlie it are also much thicker; the whole of these beds are parallel both in dip and in strike, the latter being N. 11° E. (11° more east than on Sections I. and IV.), and the former 70° W. The limestone is very much contorted, the folds being only just too large to show in hand specimens. The upper part of these calcareous slates (60) are yielding calcareous tufa (59) in large quantities, the rock in the side cutting for the road being entirely hidden in many places by thick incrustations. The slates are very like those on the Dun Mountain Tramway, which contain the annellid trails, light greenish colour, and a soft unctuous touch to the feel. Above these is a dark green compact aphanite slate (61) 300 feet thick. A dark grey almost black slate with a sandstone-like structure, and strong argillaceous odour follows, and continues down to the junction of the old and new roads on the Maungatapu. There is then a band of light grey slate of about 100 feet in thickness before the fossil beds are reached. These Fossil beds are in part composed of a dark blue fissile slate which cleaves to less than a quarter of an inch, but not with more than 20 or 30 square inches in one piece; they contain indistinct traces of fossils of various kinds. A harder slate in connection with it contains an abundance of annellid tracks and casts; the strike of all these from the calcareous slate upwards is N. 40° E., dip W. and various, but usually 70°; about a quarter of a mile from Dwyer's grey slate makes its appearance, which seems to be a continuation of that in No. II Section: these also strike N. 40° E., dip 72° W. A little below the junction blue slate, dipping 72° W., strike N. 10° E., crosses the line of section, this is soon after followed by some beds striking N. 20° E., with the same dip, viz: 70°W. The strata then become rather flatter, a belt of blue slate with quartz and calcite veins dipping 60° W., strike N. 40° E. (64) A grey green sandstone with thin bands and flakes of red slate here and there covers this, which is in turn overlaid by crystalline slate, followed by a banded cherty slate with quartz and calcite in it; it decomposes with a white argillaceous substance on the surface; the dip is 60° W., strike N. 40° E.; after this a gap of about three quarters of a mile occurs, which I could not fill in satisfactorily. The next beds met with are grey slate with quartz veins dipping 50° E.; the Brown Coal formation is found lying on the slates near Beckman's Gully, striking N. and S., dip E. 10°; below these again are rotten sandy slates running N. 40° E, and dipping E. 75°, underlaid by banded slates with the same dip and strike. Between these and the Brook-street series of Plutonic rocks, is a belt of altered slates and sandstones, and then come the diorites, separated by a few beds of slates dipping S.E. 75°, lying on the second belt of diorite and cherty sandstone and slates.

SECTION 4.

Runs N.W. from the Duck Pond to the turn in the Roding River below Wairoa Saddle.

This section needs very little description as it corresponds in almost every particular with No. I, its main purpose is to show the occurrence of two elvan dykes (33 and 34), which occur near the eastern limit of the serpentine. Another one also occurs about a quarter of a mile from the western limit, of the same rock. It is on this latter that I should recommend a trial. The dip of the slates is very irregular for about a mile when it becomes steadily W. again at 65° to 70°.

ECONOMIC VALUE.

The Economic aspects of the District were touched on in my preliminary report, chiefly in reference to gold and copper, which are the only two metals of which traces have yet been found. Galena might be found in connection with the elvans but of course, no promise to that effect could be made. Instances have occurred when the intersection of two elvan dykes has been accidentally cut while searching for copper, and rich bunches of argentiferous galena been found. One or two places are marked on the map as having fissile slate, this slate is best developed in the Roding River. A specimen I brought is 12 × 9 inches and weighes 4½lb, with a proper cleaving hammer it might be split to half its present thickness. The place is, however, too inaccessible for this slate to be of any commercial value as yet.

DUN MOUNTAIN TRAMWAY.

The order in which the specimens are arranged is descending from the Chrome Mines.

13. Is from the highest chrome working; the run of the stone is N. 30° E., but underground it is said to be N., dip W., roof serpentine, footwall dislocated serpentine.

14. Chrome and asbestos.

15. Chrome.

16. Horneblende rock, which runs parallel with the chrome on the east side, but is separated from it by a band of serpentine.

17. Cuts through the serpentine about half way between the chrome workings and Coad's Mine.

20. Massive scapolite occurs at the point of a spur with serpentine on both sides.

21. Syenite fine grained,—dyke cuts through serpentine.

22. Breccia.

101. Limestone. At one or two places a green melaphyre comes up under the limestone. Limestone dip 76° W., N. and S. The limestone gradually passes into slate by becoming interbedded with it, first in thick slabs with thin bands of slate, and then gradually giving place to more and more slate till it finally runs out. The limestone is rather contorted and is almost unfossiliferous, the few traces I found being very indistinct. It is full of calcite veins and in some places contains cubes of iron pyrites; a little lower the dip becomes 70° W. The limestone becomes apparent about 80 yards W. of Limekiln and at a place directly facing Roding Valley; the slate is in thin laminæ with limestone here and there. On the west side of the last big spur from Wairoa Saddle the slate is hard, grey, and sandy, run N. and S., dip 79° W. The general character of the slate all along the line is to be intimately mixed with sandstones and it is not needful, or indeed possible to mark each one; some of the sandstone is evidently the result of a period of *false bedding*, and is quite foreign to the essential character of the slate, but at the same time, it gives a clue to the scarcity of fossil remains, as probably they would be all scoured to places where there was slack water behind some previously formed formation. A few fossils are known to be found in the slate about half a mile below the limestone.

94. Just below the Junction Saddle the slate runs N. 20° E., dip 60° W.

93. Next to this is a slightly different class with a run N. 20° E., dip 65° W. Below Wairoa Saddle the dip becomes most confused, first E. and then W., and then vertical, all in a few yards. About half a mile below the Saddle, the strike is N. 10° E., and this is constant all the way down; the dip, however, is S.E. 60°, 300 yards further on it is W.; the westerly dip is undoubtedly the true dip of the district as far as my observations extended; the E. dip does not penetrate many feet down.

103. In the Company's quarry the dip is 60° E., strike N. 10° E.

95. About a mile below the quarry.

96. Below 95.

97. A little below first cottage from Stacks'.

98. Glen Gully.

99. Igneous rocks from lower part of tramway. These do not appear to me to be one rock, but to comprise a complete series, commencing about 300 yards above the turn at Kidner's Gully, and running into and across Brook-street Valley N. 10° or 15° E. The igneous rock is brecciated in places.

100. Occurs in the middle of 99.

WINDTRAP GULLY.

The upper part is over nothing but loose drift and sheddings from the Dun Mountain, as far as the waterfall, when a felstone makes its appearance; this is quickly followed by a regular conglomerate, composed of dunite, hornblende rock, &c., which continues down nearly to the junction with the branch of the Maitai; this conglomerate forms cliffs on both sides of the gully, and also on the branch of the Maitai; it also forms the dividing space between the two. Copper has been found in it on the Windtrap side; the drive is now fallen in, but I am credibly informed that several pieces of native copper, some 7 or 8 lbs. weight, were extracted; now, however, there are no traces of anything of the kind to be seen. Below this conglomerate a true breccia occurs, containing felstone, slate, serpentine, but no dunite. At the junction of the gully with the Maitai branch serpentine is again encountered, having a boundary running N. 10° E. Next, below this again, a breccia (55) appears; the breccia is cut through by a dyke (No. 56) running N.W., and shortly after the serpentine again occurs. A dyke, identical in every respect to No. 34, makes its appearance in the serpentine, in just the same manner as 34 does; it runs N. 15° E., dip S.E. A little below this again is the slate with the limestone, similar to that on the Tramway, N. 40° E., dip 76° W.; immediately after this the blue, pink, and green slates crop up, and continue all the way to the junction without a break; the junction is 2,000 feet below the top of Maitai branch.

MAITAI RIVER.

The upper part, as shown on the Maungatapu Road, is all loose boulders, but which nevertheless represent the upper part of the series (specimen 57). The first rock *in situ* is a small patch of serpentine above the bridge; below this, limestone occurs in large masses, *in situ*, reminding one of the Dun Mountain Tramway, N. 11° E., dip W. 70°. This limestone is very much contorted; it is followed by slates in layers, slates, and, lastly, by a fine aphanite. Half a mile above the junction true slates occur, running N. 40° E., rather contorted, and appearing to dip all ways; this slate is fossiliferous, but the fossils are very scarce, worm tracks being the most distinct and numerous. Below the junction the slates dip 72° W., running N. 10° E., and, a little further on, N. 20° E., dip 70° W. A little below Aniseed Flat quartz and calcite veins occur, running N. 40° E., dip 60° W.; the slates in this place are green. About half way between Aniseed Flat and Smith's the slates run more easterly, and about half a mile below Smith's they have a course N. 40° E., dip 60° W. In this place they are banded and rather cherty; the slates then continue without change to the alluvial flat land.

RODING RIVER.

Commencing at the Dun Mountain Saddle, and passing over the felstone slates, as shown in Section III., the hornblende rock is found, which continues down the stream for some distance; this hornblende rock is the eastern boundary of the chrome deposit; it runs N. 30° E., dip W., and continues across the river on to the bare hills towards the Serpentine River. The actual junction between this rock and the serpentine is not visible, but the approximate position is marked on the accompanying plan. The serpentine continues for upwards of a mile down the stream; and is dislocated by several intrusions of igneous rocks; one in particular is worthy of notice—it runs N. 40° E., and is almost perpendicular; it does not cut right through the serpentine, the top of it being 800 feet below the Tramway. The position of this dyke is S. from the old copper trials, at a point on the river S. 50° W. from the old ore mine. A dyke of hard porphyritic felstone occurs in a similar manner to the one above mentioned, only penetrating the serpentine for a few feet above the bed of the river; the dyke runs nearly N. and S., with a very slight inclination of 3° from the vertical to the E.; laying on this is a lode, containing ore and other metal, which is well worth examining; this lode is not the same as that found on the hill side, being of quite a different character, and having a dip in the opposite direction. The one that has been tried dips W., and is, I believe, not a true lode at all, but merely a fissure, which has been an escape for chemical waters holding ore in solution. The nature of the lode is very unpromising, being hematite, with flakes of copper ore here and there on the joints; and, without a change of ground, there is very little probability of any improvement. To follow such indications is always very expensive, and generally futile, as it seldom happens that they run through to the main body ore, from whence the indications have been derived. The indication in the bed of the creek, however, is of quite a different nature; it presents a good *gossan*, and is bounded by a true plutonic rock on one side, so that there is a probabibility that a small outlay would prove whether it was worth while to prosecute the search farther or not. It does not seem to cross the stream with much power, but that is of little moment.

RODING RIVER AND ANISEED VALLEY SPECIMENS.

33. Three-quarters of a mile from Mine Saddle, occurs as a dyke in the serpentine, between two low bare spaces.

34. Cuts through the serpentine, having a course N. 40° E., nearly vertical; it forms a dyke 10 feet thick, which crosses the stream about 700 feet below the Tramway. This dyke only forces its way up for about 12 or 14 feet above the bed of the creek, thus having a thick cover of serpentine over it; this is nearly south from Coad's Mine.

70. N. 50° E. from Coad's Mine. The specimen is from a lode which runs parallel to and in contact with a hard porphyritic dyke (elvan); the dyke does not cut through the serpentine, being very similar in character to that at 34; the course is N. and S. This is worth examining for gold and other metals.

71. Crosses the river at the boundary of the Black Bush; is 150 feet thick.

72. From boulders at the same place; I could not find any of this *in situ.*

73. Breccia, 210 feet thick.

74. Just above the Limestone Cliff.

75. Is from the limestone; whether it really is a fossil or not is an open question. This limestone is identical with that in the Tramway, of which it is a continuation in a S. 10° W. direction; dip, if any, W.

76. From the green slate just above the limestone; N. 10° E., dip 70° W.

77. Green slate; this slate gradually becomes vertical, and is full of quartz leaders.

78. Quartz from 77. There is a very interesting heave in the slate just at this point, when it becomes vertical; the throw is 9 inches westwards.

Below this again limestone and slate, mixed in thin beds, make their appearance, N. 30° E., dip W. 55°. Below these again 71 appears. Farther down a dyke (*f* 71) again appears, coming through the slate, which has had the effect of causing the slate to stand vertical just on each side of it and on the top, sloping towards it for some little distance. All round the dyke is a hard bluestone.

79. Is probably metamorphosed slate.

80. Below this again is a limestone, having the same character as that on the Maungatapu Road, and having the same incrustation.

81. A band in the slate, somewhere below Wairoa Saddle; the dense bush makes it impossible to tell the exact locality. Below this again is a belt of sandstone similar to that in the Tramway, next the sandstone and rotten slates.

82. Runs E. and W.

The slate then continues without change all the way down to the Bare Hills.

83. From a band of red slates, which are full of quartz reefs.

Shortly after this the flat land begins.

SERPENTINE RIVER, A BRANCH FROM ANISEED VALLEY.

84. Is from the hill just behind Hackett's Mine; there are two varieties of rock, but they are joined into one mass.

Hackett's mine is now all fallen in; there appears to have been a semicircular cut made through a narrow space, composed principally of hornblende rock and serpentine.

85. Is close by 84.

The general formation of the river is very similar to the Upper Maitai. On the west side, about half a mile above Hackett's Mine, is Everett's copper trial; the drive is in the serpentine.

86. Is a specimen knocked off the lode at the end of the drive. It will be at once perceived how much superior it is to the Dun Mountain copper. The drive runs E. 30° N. for about 40 feet; at the end of this is an oblique cross cut on the course of the lode E. and N.

87. Is the foot wall; the lode is, however, vertical.

88. A loose piece, locality not known.

89. Chrome from a drive and open cut on the same side of the river as Everett's Mine, but at a considerable elevation above it. This is nearly south from Hackett's Mine; it is evidently on the same run of ore, as a considerable quantity of chrome appears to have been extracted from here.

90. Is from the west flank of the hill on which 89 is situated, and almost immediately below it.

A band of light blue felstone runs N.E., nearly vertically, bounded by slates on the W. side, and breccia on the E. Conglomerate also lies on the serpentine. The whole area is strictly analogous to the Dun Mountain, and, to complete the parallel, I found some dunite, but only in loose pieces. I imagine the rock itself must be some distance away.

91. Is from the track to the other mine, 3 miles back in the hills; it is in serpentine, but nothing much was ever done there. This specimen requires examination.

Hackett's Mine is, as nearly as I can work it out, N. 60° E. from Dun Mountain Saddle; and is 2,020 feet below the Dun Mountain Saddle.

General Character of Roding River.

The first or upper part, being chiefly over hornblende rock and serpentine, is by no means bad travelling; but, when once the limestone is passed, the river is almost one continuous gorge, particularly so where the course of the stream coincides with the strike of the slate. The whole formation is exactly the same as that shown in the Maitai and Tramway sections, as far as constituents go; the bedding of the slate is however, more regular and less contorted. The structure of the dykes 33, 34, and 71, are features to be particularly noticed. I only noticed good fissile slate in one place, and that would not cleave to less than a quarter of an inch.

WANGAPEKA DISTRICT.

23rd December, 1870.

The district of the Wangapeka Valley has long been recognised as a gold-producing country; but until lately the attention of miners has been entirely devoted to the search after alluvial gold in the beds of the different rivers and creeks. In the spring of last year a prospecting party, which had been sent out from Nelson, discovered gold *in situ* in a reef on the spur between Blue and Nuggetty Creeks, near the head of the Rolling River, and about 38 miles, in a direct line, to the S.W. of Nelson.

The Rolling River is a tributary of the Wangapeka, a branch of the Motueka, which runs into the sea some 25 miles W. of Nelson, and 36 miles N.E. of the reefs. A township has been laid out on a flat just at the junction of the two creeks, which at present is represented by three or four stores and public houses, which are, amply sufficient for the wants of the place, there being only about 150 men at work on the hill, and most of those are very short of money.

The district, from a mining point of view, may be considered as composed of altered slate, more or less crystalline, traversed in all directions by innumerable quartz veins, the masterl odes running N.N.W. The sides of the spur are so precipitous that all the reefs may be worked dry, *i.e.*, above an adit; and 300 or 400 yards of fluming would bring in an unlimited supply of water on either creek. The spur, on the lower part of which the reefs now being explored are situated, rises abruptly to a considerable altitude, terminating in one or two bald peaks, which tower up clear and distinct above the dense bush which covers the rest of the hill.

The limestone which overlays the slate is extremely hard, sub-crystalline, of a dull grey colour, and is traversed by numerous veins containing aragonite; it is also much waterworn on the surface, and in one or two places shows a waterworn vertical section; there are also several caves, through one of which the water of Blue Creek runs for some distance. The strike and dip vary considerably; at the place where the Blue Creek issues from the cave, the strike is N.W., dip 35° S.W., and about a quarter of a mile farther up the hill to the north the dip changes to 10° N. The slate, in some places, closely resembles that at Bedstead Gully, Collingwood, and at others assumes a more crystalline character, nearly approaching a gneiss; pyrites is commonly disseminated through the mass, and quartz veins and leaders are plentiful; it is evidently much older than the limestone, which latter rests on its waterworn surface, and appears more like a local deposit than the remains of a large sheet which had been denuded away; it reminded me, by its mode of deposition, of the Bala limestone of England, which occurs in isolated though contemporaneous masses throughout a considerable tract of country. I can hazard no conjecture as to the geological age of these deposits, as the time at my disposal did not admit of a very minute search for fossils, which, owing to the metamorphism the limestone and slates have undergone, will, if still existing, be very indistinct and difficult of detection. The metamorphism is probably due to the large mass of granite which crops up in the Wangapeka River, about four and a half or five miles to the north, and also at Mount Owen, about two and a half miles to the south.

THE REEFS.

Most of the claims which have been taken up have been done so with the idea of securing a section of either Culliford's or Doran's reefs; this has been done without exercising much judgment, or making allowances for the rise and fall of the hill; the consequence is that some of the claims are pegged out where the reef intended to be struck cannot possibly exist, and the men are constantly shifting their pegs to suit some new fancy, and very little actual exploration is effected, but this may also be attributed to the want of machinery. Culliford's Reef, on the east or Blue Creek side of the spur, was first discovered in a little stream now called Culliford's Gully, somewhere about 20 chains from the northern extremity of the limestone, and at an elevation of 720 feet above the township. The roof and footwall are both alike, being blue slate with a small quantity of pyrites disseminated through it; the reef runs N.W., with a very irregular dip to the E., the average being about 7°; the quartz is not uniform in texture, being very hard and white in some places, and soft and iron-stained in others; there are no defined partings between the slate and quartz; a thin band of mullock here and there may be seen, but it is not constant. I was assured on all hands that very fine specimens of gold are constantly being found, and that sometimes they are quite plentiful in the paddock, but, although I searched diligently myself, the manager assisting me, I did not find a speck, much less a specimen of gold. I am, therefore, bound to conclude that the reef is exceedingly patchy, and therefore it is very problematical whether the rich patches will occur often enough to pay for working; it is also an open question yet whether the mass of quartz contains invisible gold in payable quantities or not; I doubt it myself. The prospects of this claim are also rather damped by the occurrence of a well-marked slide in the drive, which appears to cut through everything, and will strike the reef at a depth of 33 feet or less below the level, when it remains to be seen if it *throws* the reef or not; this ought to be proved before much expense is incurred. To the south of this claim, and supposed to be on the same leader, are Culliford's No. 1 South, and the Golden Crown *alias* Hunted to Death claims; the leader in this latter runs N.W., and is nearly vertical; it contains a quantity of pyrites, and frequently rich bunches of galena, which vary in size from an ounce to 10 or 12lbs. weight; I saw one which weighed 14lbs. The matrix of the reef is a hard grey quartzite, somewhat resembling a rock occurring at Tararu Point, and also at Coromandel. Culliford's No. 1 North is the only claim which can be said to have struck Culliford's Reef with any degree of certainty.

Doran's Reef, on the western side of the spur, is more easily traced than Culliford's, and consequently a much greater number of claims have been pegged out on it, both above and below the original discovery. When first opened on in Doran's No. 1 Claim, the reef exposed a face of quartz and slate mixed, some 15 feet in width; but now that the slipped ground has been taken away, this is reduced to 5 feet 6 inches of solid quartz, running north and south, with a westerly dip of 83°. The boundary of the quartz is well defined, both roof and footwall standing hard and distinct against the quartz; both walls are alike, being a blue-brown gneissic slate; gold may be seen in almost any piece of ston taken at random off the heap, if carefully examined with a lens.

Doran's No. 2, supposed to be on the same reef, is, if visible gold may be taken as a criterion of value, one of the richest claims on the field. The reef is very confused, and appears more like a slip than a vein *in situ*; it is also very much broken and dislocated. The strike is more or less north and south, but the dip is any way; at first it was west, then it turned to the east, and when I saw it seemed as if about to turn back again. The country is slate, like Doran's No. 1; the quartz hard and massive, alternating with a brittle cavernous variety; it is this latter which contains most of the gold hitherto found; the gold is contained in the cavities, but is quite unattached, so that when specimens are dry it may all be shaken out. This shows, I think, that the gold has been deposited there by precipitation at a low temperature. Good prospects are also washed out of a loose rubbly mullock which accompanies the reef. A most interesting deposit of native sulphur is also found in this claim. Some of the sulphur appears to have been simply deposited by cooling, while other parts have been fused while in their present position. Bearing in mind Mr. Skey's late discoveries, it at once occurred to me that probably the gold in this claim would not amalgamate, and such has proved to be the case, for, on forwarding to him a "prospect" Doran kindly washed out in my presence, it was found to resist all attempts at amalgamation; whether this will affect all the claims in the same way I cannot say, but they are so close together that probably they will all suffer more or less from this cause; immediate attention ought to be paid to this, for it is certain that amalgamation will not save the gold.

The Donkey Reef, below Doran's No. 2, dips E., with a N.W. (N. 35° W.) strike, and closely resembles Culliford's, but is much more clearly defined.

The slate hills on both sides of the spur, that is, on the east of Blue Creek, and on the west of Nuggetty, are full of quartz veins; several claims have been pegged off on the Nuggetty side. Fawcett's is one of the most developed of these; the reef is hardly defined, being irregular bunches of quartz, with small leaders, in a country of blue slate. The run of the leader is N. 10° W., dip 35° W.

COLLINGWOOD DISTRICT.

December, 1870.

Immediately on leaving the town of Collingwood a large tract of alluvial ground is entered on, which stretches away some eight or nine miles in a south-westerly direction, this plain is bounded on the the north-west by the Aorere River, on the north by the sea, and on the east by the Te Para Para; towards the south-west the drift deposit of which it is composed ends on the slopes of slate and schistose hills near Bedstead Gully, &c. The most striking feature about this flat land is the succession of terraces by which it rises as it recedes further inland, and also a few islands and rocks, which here and there rise up above the level of the surrounding drift. The drift is composed almost entirely of quartzite, quartz, and schist in rolled pieces; but in a few instances I noticed the presence of subangular fragments. Gold may be found in all parts of the drift, but only in payable quantities in a few localities, which appear to me to be those places where the materials have been re-sorted, and the gold concentrated by the action of running water, subsequent to their original deposition.

One of the most remunerative diggings ever discovered in this system of drift was that on Appoo's Flat, where at one time upwards of 300 diggers were employed, and all doing well; from the little information I could gather, it appears that as soon as ever the yield of gold fell off, the men gave up their claims and went to the West Coast, the consequence is, that while the best of the ground has been worked, there still remains a great deal untouched which would pay a moderate dividend for working. At present the flat is quite deserted, except by one "hatter," who seems to work a few hours a day, and says that he can do very well as long as he remains a "hatter," *i.e.*, without any mates.

The wash-dirt in this particular place consists of brilliant white quartz, and quartzite with ferruginous stains. About the middle of Appoo's Flat a shaft was sunk, 120 feet in depth, some men in the neighbourhood told me that it bottomed the drift, and found that it rested on limestone, others again assert that the bottom of the drift was not reached, both however, agree in stating that there was no water to contend against, and they agree about the depth.

The junction of the schistose slate and limestone must be somewhere under Appoo's Flat for on passing up the gully quartzite and quartzoze schist are encountered, striking nearly north and south, the latter carrying numerous quartz veins. The bed rock of the upper part of Appoo's Gully is a crystalline limestone, which is succeeded near the Parapara by a half decomposed granite, the strike of the limestone is north and south, the granite seems to make to the east near Ernest's Saddle. The schist and quartzite which are found in the lower part of the gully continue to the north in a line parallel to Glengyle Gully, forming the hills on its western side, to the south they continue past the head of Lightband's

Gully, through the Pioneer Company's ground, and are found again in Coles' Gully; the limestone evidently rests on this in isolated patches. In Bodstead Gully a blue altered slate is found under the shistose rocks, it crops out to the surface near the outlet of Coles' Gully, it can be traced up Bedstead and over into Kelly's Gully.

It is certain that there are no rocks in their normal condition within a considerable area in the eastern side of the Aorere River, except perhaps parts of the limestone. That there must be an immense area of metamorphic rocks is evidenced by the extraordinary accumulations of drift, composed entirely of pebbles and boulders, derived from that description of rocks.

ALLUVIAL WORKINGS.

A few parties are still engaged in the different gullies, on this class of diggings, who as a rule, are earning a living, but very few are doing more; some of the best claims are Lightband's, Hit-or-Miss, and the Glengyle. The Glengyle has been steadily worked for a number of years by the same party, who seem to have unlimited faith in its capabilities, as for the last two or three years they have been engaged in removing the débris from a slip which filled the whole of their workings, and has almost entirely prevented them from getting any gold during that period; they hope however to be able to resume operations some time this summer. The gold occurs in four distinct beds, the lowest of which is generally the richest, the order of these four beds is—1st, blue mullocky wash-dirt; 2nd cream-coloured gravel; 3rd, finer dirt with red gravel; 4th, rough dirt, rich in gold; underneath this is sand and river detritus, with no gold, the bedding is pretty regular, east and west.

The Hit-or-Miss claim on the north side of the saddle which divides Glengyle from Appoo's Gully, is very similar in character to Lightband's, which I shall next describe, this claim is the first, I believe, in which the method of hydraulic mining was adopted in this country, and the same system is in use at the Glengyle claim, where they have 120 feet of pressure, anduse two and a half inch nozzles with good effect.

Lightband's claim on the south, or Appoo's Gully side of the saddle, promises to turn out very rich wash-dirt, and the party are sparing neither trouble nor expense to enable them to thoroughly and systematically exhaust their ground: a shaft sunk 53 feet gives the subjoined section:—

1.	Yellow clay	15 feet
2.	Loose sandy quartz drift showing the "color" ...	5 feet
3.	Red wash-dirt	11 feet
4.	Blue wash-dirt with blueish quartz, and rich in gold not bottomed at	27 feet

The bedding is westerly.

Golden Gully is, I believe, almost abandoned, but does not appear to have been thoroughly exhausted. Lightband's Gully is also deserted.

REEFS.

Only one reef has as yet been worked to any extent, so that it is very difficult to come to any definite conclusion regarding the ultimate prospects of the district; several have had a few days work expended on them but not sufficient to show the character of the reefs.

The Perseverance Reef naturally takes precedence of all the others, as it is the only one which is at present yielding gold in notable quantities; it is situated at the head of Bedstead Gully, exactly on the junction of the crystalline rocks and the slate, the one forming the footwall, the other the roof.

The reef, dips to the east, varying considerably in the thickness of quartz and the amount of dip. The fissure in which the quartz occurs has been caused by the movement of one or other of the two rocks, through a vertical space of 12 or 15 feet; this movement has been slightly diagonal, viz., 25° to the south of vertical; it is self-evident that if one of two hard, rigid, mammillated surfaces, resting and fitting on each other, be caused to slide in any given direction, it must form a fissure of greater or less magnitude, according to the size of the mammillations. The vein itself is not one continuous sheet of quartz, but consists of a quartz breccia, with a little slate and slate powder in it; and in one place, where the reef is little more than a quartz sand, gold may be washed out in an ordinary pan; very fine specimens are also sometimes found in the solid parts of the reef. The fissure or reef is cut off by a cross course of blue graphitic slate, which seems to turn it round completely on to itself again. This slate is quite different to that ordinarily found in Bedstead Gully, which does not contain graphite, and does not, to my knowledge, appear anywhere on the surface; it is so soft that it is extremely difficult to carry without being crushed to powder.

The other claims are hardly worth mentioning. The Masonic and Decimal are adjoining the Perseverance, but neither have yet done any work to prove their ground.

In Coles' Gully the Ophir and the Commercial attracted my attention; the former is situated near the head of the gully, and has a brown ochrey leader, running north 30° west, dip east, nearly flat; the country is schistose slate. A few tons have been extracted, and sent to the Perseverance battery for trial, but they had not been crushed when I left. The Commercial, near the lower end of the gully, was opened on a mass of quartz, which was said to show gold; the quartz is hard and white, sometimes containing white mica; strike north, dip east.

There is one claim worthy of particular notice, as having been taken up to work for copper ore. The lode is situated about half-way between Appoo's and Bedstead Gullies, and may be traced on the outcrop for a considerable distance; a shaft has been sunk to a depth of 60 feet, and now the funds are exhausted and the work at a standstill. This is very much to be regretted, as the lode contains some fine specimens of chalcopyrite; and although the matrix is not such as usually carries ores of that class, it is remarkably promising, as the character of the lode is uniform, and as long as such is the case a rich course of ore might be cut at any moment, if this sett was in England or any other real mining country it would not be allowed to remain idle for a single day. No metalliferous lodes are uniform, for a few fathoms no ore is found, and then a rich course is cut, and so on, and the manner in which the ore occurs in this lode gives every hope that it will make into bunches in different places, though where, it is impossible to indicate.*

PRELIMINARY REPORT ON THE MALVERN HILLS, CANTERBURY.

BY JULIUS HAAST, Ph.D., F.R.S.

July, 1871.

THE greater portion of the Malvern Hills proper, fixing their boundaries in the south by Rakaia, in the north by the Waimakariri, and in the west by the eastern base of the Thirteen Mile Bush and Mount Torlesse Ranges—consists of palæozoic sedimentary rocks, mostly sandstones, slates, shales, and conglomerates, with interstratified diabasic beds, associated with cherts and semi-crystalline (altered) limestones.

Near their eastern boundary, towards the Canterbury Plains, the lowest beds of this series are exhibited in the Cairn Range, on the northern bank of the Selwyn, and stretching across that river towards the Upper Selwyn, in the direction of the Upper Rakaia Gorge.

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* Specimens of this ore forwarded to the laboratory, showed copper pyrites contained in cavernous quartz. The quantity of copper present in the pyrites after separation being 29·1· per cent., proving the quality of the ore to be superior,—the proportion of copper in marketable ores varying from 5 to 34 per cent. The value will, however, depend on the proportion of the ore to the quartz matrix and the facility which the lode presents for working. The portion of ore examined also contained silver to the amount of 1 oz. 12 dwt. and 13 grs. per ton, and distinct traces of gold. The cavities in the quartz are lined with a black pulverant mineral, having the following composition:—Copper, 63.36; sulphur, 24.81; iron, 11.83. This mineral therefore belongs to the class of varrigated copper ores.

CARBONIFEROUS SERIES.

These lowest visible beds consist of conglomerates, coarse sandstones, and shales, with Pecopteries and Tæniopteris and other remains of plants, which, according to Professor McCoy, are identical with those obtained in the coal fields of New South Wales, and are probably of Carboniferous age. Occasionally small seams of impure shaly coal occur amongst them, but they are only a few inches thick, very irregular, and of no commercial value. I observed also, similar thin seams, sometimes of a bright coal, in the Clent Hills on the north bank of the main branch of the River Ashburton.

These beds contain, besides good building stones, consisting principally of coarse flaggy sandstone, in the Cairn and Manuka Ranges, marble in various localities, but owing to its numerous joints, it cannot be used for large work, such as chimney-pieces, columns, &c., unless when the quarries are opened up, the blocks should prove to be more massive below the ground. In any case, it will form valuable material for excellent lime. The beds which are easiest of access are those on the left bank of the Selwyn, in Frank's Knob, immediately above the so-called Copper Gorge; they are also reached with facility from Russell's Flat (Hawkins) over a low saddle. The deposits on the eastern face of the Four Point Range, above Mr. Hill's station, may also be quarried advantageously in several localities.

No indication of ores of any kind have hitherto been found in these sedimentary beds, if we except a few small veins of Hausmannite (manganese) and nodules of clay iron ore in some carbonaceous, shaly beds.

QUARTZOSE PORPHYRY GROUP.

These sedimentary strata have been broken through and disturbed by masses of quartzose (trachytic ?) Porphyry, having sometimes quite a granitoid appearance, forming two separate zones, of which the northern (Mount Misery) is separated from the larger southern one by a narrow belt of palæozoic sandstone running from the Golgatha Range towards the Hororata.

These two mountain systems, the Mount Misery and the Snowy Peak Ranges, contain a variety of rocks, such as quartzose porphyries, granites or granitoid porphyries, trachyte porphyries, trachytes pearlites, pitchstones, melaphyres, and amygdaloids, which are traversed in many localities by veins of quartz, too chalcedonic to be auriferous, an inference confirmed by having been tested for gold without success. However, as in other parts of the world, similar combinations of rocks yield valuable ores, it would be premature to conclude from the partial trials hitherto made that ultimately no favourable result would crown mining enterprise. These rocks are also very rich in geodes of agate and chalcedony, which, one day, might form a valuable export to Europe, for the manufacture of the so-called oberstein articles, for which, at the present time, the raw material is mostly obtained from Brazil and the Ural Mountains, worth about £30 per ton in European ports. Some of these quartzose porphyritic rocks are of great beauty and variety of colour. They occur also in very large blocks, showing such planes of division as granites generally exhibit, and will form fine material for the erection of public buildings, or for columns, and other ornamental purposes, for which, from their hardness, durability, grain, and colour, they are well adapted.

Upon the slopes of these porphyritic rocks large beds of tufas are deposited in great variety of form and material, and ranging from good fire clays to very coarse conglomerates, made up of large boulders of porphyry.

Here and there small seams or nests of shales with coal are embedded in them, which are, however, unworkable. Beds and nodules of fine clay ironstone are in some localities in such abundance and of such good quality* that in years to come they will be very valuable in the manufacture of iron.

In this series of tufaceous beds, which, in some localities, are of enormous thickness, we therefore possess fire clays, clay iron ore, and also building stones; the latter, however, are not of great value, being generally too soft.

Brown Coal Series.

Upon these tufas reposes the great brown coal formation of this portion of New Zealand.

In many localities, however, where it has not been protected by favourable circumstances, it has almost been entirely removed by erosion, its former existence being only indicated by small remnants of shale and brown coal, which are often situated high on the mountain sides.

On the eastern boundary of the Malvern Hills, towards the Canterbury Plains, such favourable circumstances did, however, exist; a sheet of dolerite having formed a protective cover over the green sands and loose quartzose sands overlying the coal deposits.

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* See Dr. Hector's report on the geological structure of the Malvern Hills, *ante*, p. 47, etc.

In other localities between the palæozoic rocks the brown coal beds have, to a more limited extent, been preserved by dykes and coulées of basaltic rocks, by which they have undergone more or less important alterations, the changes ranging from an excellent brown coal up to a true anthracitic coal. Generally, however, the action of the igneous rocks has been so effective that we can, with a few exceptions, fairly describe the coal in these outliers as highly altered, and thus divide the whole into two well-defined series, namely, the unaltered brown coal, consisting of beds along or near the boundaries of the Canterbury Plains, and the altered coal in small isolated patches, more in the interior amongst the palæozoic and porphyritic rocks. The former beds begin in the southern banks of the Hawkins, and continue without any interruption, except where broken through by the Wai-ani-wha, the Selwyn, and a few minor streams, to the northern banks of the Hororata, near Rockwood, following everywhere the contours of the higher ranges.

Hitherto the brown coal seams contained therein have only been worked regularly at the Hawkins, where the whole thickness of the coal-bearing strata has been well exposed. In that locality, three seams of brown coal of fair quality* have been worked successively, of which the lowest set, consisting of two seams of two feet each, with two feet of shale between them, is the thickest, and is at present worked by Mr. J. Jebson. I have followed these brown coal measures along the whole line of their occurrence over an area of 16 miles, and found them more or less exposed in twenty-two different localities, in deep gullies, land slips, and in the lower gorges and banks of the rivers and streams.

In some spots the indications were followed up, and the seams exposed with pickaxe and spade. They appear to be most largely developed in the Surveyor's Gully, where I discovered a seam more than six feet thick, overlaid by a seam of more than three feet, separated only by about two feet six inches of shales, thus offering about three yards thickness of excellent brown coal for extraction.

Indications of well-developed and regular seams are not wanting on both sides of the River Selwyn, where the river cuts through the brown coal formation. Further south, on the eastern slopes of the Mount Misery Range, similar seams of brown coal are exposed in several gullies, but do not offer such facilities for working them, and do not possess the same thickness as in the Surveyor's Gully and the adjacent country. Finally in the bed of the Hororata they have dwindled to inconsiderable thickness, and deteriorated much in character, so that they are of no practical value.

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* See Dr. Hector's report, *ante*, p. 54. Abstract of analysis of coal from Malvern Hills.

Selwyn Coal Series.

The seams of brown coal on the northern bank of the Selwyn being of great importance, a few more details concerning them will not be here out of place.

Concerning their quality, I beg to append the analysis made at Wellington in the Laboratory of the Geological Survey of New Zealand, which proves clearly that both seams consist of an excellent drown coal, superior to the Bohemian brown coals, so extensively used for household, steam, and other technical purposes in that part of Austria:—*

A. Upper Seam; B. Lower Seam. Brown coal, homogenous, colour in mass, pitch black; powder, brown; surface fissured by dislocation, ash white.

	A.	B.
Water	17·50 ...	18·88
Fixed Carbon	44·50 ...	40·01
Hydro Carbon	31·22 ...	37·61
Ash	6·78 ...	3·50
	100·	100·

The dip of the strata being about 20 to 22°, and the altitude of the hills about 300 feet above the valleys, the two principal seams can be mined level free over an area of three miles, and a breadth of about 270 yards which would yield about 3,200,000 tons, taking one and an eighth cubic yards of coal as equal to one ton weight.

In this estimate I do not include the smaller seams, which are also not wanting, nor the coal which will be found below the surface of the valleys, but which can only be obtained by sinking, and thus causing additional expense in bringing the coal to bank. Neither do I include the coal seams now worked by Mr. Jebson and their continuation to the northern bank of the Wai-ani-ani-wha, nor those on the southern bank of the Selwyn River, which latter will doubtless also be opened by mining enterprise if a market can be reached by railway communication.

Other brown coal seams of superior quality occur at Rockwood, others on the north-western slopes of Mount Misery and behind the Thirteen Mile Bush Range (Big Ben) and some other localities, but they are either of too small an extent or present such difficulties of access to be at least, at present, unavailable for mining purposes.

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* For Complete Table of Composition both *proximate* and *ultimate* of these coals from the Malvern Hills, see Lab. Rept. 1871.—J. Hector.

ALTERED COAL SERIES.

The next beds under consideration are the beds of *altered* brown coal, occurring in different isolated localities, of which those near Mr. H. P. Hill's home-station, Selwyn, on the right bank of the Kowai River, and in the gorge of the Acheron River, are the most important ones. As far back as 1861 the altered coal seams on the northern bank of the Selwyn were pointed out to me by the late Mr. R. Knight, who had repeatedly extracted coal from them, so that the locality was known in the neighbourhood as "Knight's Coal." Owing to the fact that these seams were rather thin, twenty inches being the thickness of the largest of them, and the whole outlier of small extent only, I did not consider them of sufficient practical value to include them in the localities then recommended to the Provincial Government for reserves.

Mr. M. B. Hart, of this city, and some other parties have since bought the ground on which these coal seams occur, and they have, to a limited extent, been worked, the excellent quality of the coal* having soon procured a ready market for it, besides being extensively used in the neighbourhood, drays coming as far as forty miles to fetch it.

Lately, Mr. H. P. Hill, following some indications on the surface of his property on the southern side of the Selwyn, was induced to undertake some preliminary works, which proved clearly that the coal seams of the northern side are here more developed in extent and thickness, that gentleman having cut through a seam of fine altered coal of two feet six inches, and sinking upon another of nearly four feet in thickness, concerning samples of which the following memoranda have been furnished to me by Dr. Hector.

C. Upper Seam.—Massive, compact, friable, lustrous, homogenous, non-caking; colour in mass and powder, black; ash, brown.

D. Lower Seam.—Massive, less friable and with less lustre than *C.*, made up of laminæ of jet and dull coal, non-caking; ash, brown.

	C.	D.
Water	2·12	9·98
Fixed Carbon	67·49	53·30
Hydro Carbon	17·89	33·97
Ash	12·50	2·75
	100·	100·

The characteristic features of the whole formation are well exposed in Mr. Hill's drive, indicating that the eruption of the igneous rocks during and after the disposition of the coal seams has altered the brown coal so much as to give it an anthacitic character, or at least that of a good true coal.* The coal and the geological features being alike on Mr. Hill's and Mr. Hart's properties, about two miles distant from each other, and some other localities situated between them showing similar indications, we may conclude that the coal seams throughout this whole outlier have undergone the same mrtamorphic changes, and will, therefore, be found to consist of an altered coal of good quality.

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* Dr. Hector's report, *ante.* p. 54. Abstract of analysis of coal from Malvern Hills.

However, I wish here to observe that in some other localities, where the eruption of the igneous rocks has been confined to a more limited space, the seams only in their immediate neighbourhood have undergone important changes; whereas lower down in the series they still possess all the characteristic features of a true brown coal.

Nevertheless, as before observed, I think sufficient reasons may be brought forward to assume with safety, that the action of the igneous rocks in this Selwyn outlier has been on such a large scale that the change has been pretty uniform throughout.

I purposely avoid using the expression *basin*, because, except in the gorge of the Rakaia, the coal seams are nowhere arranged in that form, all the strata having invariably an easterly dip, thus abutting against the older rocks in the east without rising again. This is a curious feature in our coal-bearing strata, of which I shall treat more fully in my final report.

It being evident from the character and form of the coal seams in Mr. Hill's drive, that only their uppermost portion was cut through, some of them thinning out altogether, it became patent that the main portion of the coal field could only be reached by shafts.

Mr. Hill therefore began to sink upon the coal six chains to the east from the mouth of his drive, and reached the shales belonging to the coal measures after attaining a depth of forty-five feet; but since then that gentleman has been prevented from going deeper, owing to the incompleteness of his arrangements for the lifting of the water from the shaft. I have carefully traced the extent of this outlier, and find that it is about two miles long and half a mile broad, which would give us a square mile over which we might expect to find workable seams, even assuming, to be quite safe in our calculations, that the coal to be extracted were only one yard in shickness, this would give us 3,000,000 tons of coal. And even should that area, by the occurrence of igneous rocks amongst the coal measures, become restricted to half that amount—which, however, we have no right to assume—it would certainly be highly valuable to the colony, as it would give us yearly 20,000 tons for seventy-five years. I may here observe that the locality is easily reached by a railway or a tramway. In my final report I shall, of course, give all necessary details upon which these conclusions are based, and I have no doubt that if properly worked this coal field, although of such a limited extent, will pay well for the extraction of the coal.

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* None of these altered Brown Coals have acquired the property of *caking* or yield a coherent coke.

Kowhai Mine.

Another coal field of a similar character exists on the right bank of the river Kowhai, a small tributary of the Waimakariri, six miles above its confluence, but it is like the Selwyn field, almost entirely covered up by masses of post-pliocene shingle deposits.

In the year 1861, I made a minute examination of that locality, in which I was materially assisted by the excavation of several drives. The results were embodied in a report addressed to the Provincial Government of Canterbury, and which was printed at the time.

I cannot add anything to that report, and must still recommend that borings should be undertaken towards the centre of the flat, in order to test the real value of the ground, as I think it most probable that good workable seams of altered coal will be reached more towards the centre of the flat country.[*]

Dykes of the peculiar basaltic rock, associated with our coal measures, have also been found in the Kowhai during the mining operations, and to their existence the coal owes its excellent quality. A third locality, containing similar beds of coal, and which are of some practical value, is situated in the gorge of the river Acheron. The coal is of a fine anthracitic character,[†] the main seam about four feet thick and in a workable position, but of a limited extent only. Here also the occurrence of large dykes and streams of basaltic rocks has preserved the beds, and has produced the metamorphic action upon the coals and shales. The basin immediately above the gorge of the Rakaia, containing some seams of altered anchracitic coal, is of too small an extent, and the seams too impure to be of general use.

I do not think they will ever be worked, except, perhaps, for the supply of the immediate neighbourhood.

Overlaying these coal measures we meet with calcareous beds in many localities, sometimes of considerable thickness, either consisting almost entirely of shells (shell limestone) or having the character of an argillaceous limestone, the latter in the form of concretions or of septaria. Both will be very useful, either for the burning of lime or the manufacture of Roman cement. There are beds of the former character in the Selwyn, near the Wai-ani-ani-wha, and in the Oyster Gully; of the latter we find deposits above Hart's Coal Mine, in the Hororata, in Yorkie's Pass Creek, and in some other places.

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[*] For analysis of the Kowhai coal, see Dr. Hector's report, *ante*, p. 54.

[†] Ditto Ditto.

Finally, some of the doleritic lavas will be of value for building stones, paving stones, and for the preparation of millstones, for which they are extensively used in Germany, and even exported to many parts of the world.

PRACTICAL SUGGESTIONS.

The foregoing geological examination of the Malvern Hills was undertaken principally with the object of deciding the question whether there was sufficient coal to warrant its extraction on a large scale, and procure the means of supplying part of the New Zealand, or at least the Canterbury, market with the produce of our own mines.

In my report I have shown that in the district under review there exists two principal series of coal, which, generally may be described as containing *unaltered* and *altered* brown coals. The former strata begin on the southern banks of the Hawkins, where Mr. Jebson's Coal Mine is situated, and continue without interruption, except where broken through by the Selwyn and its tributaries, to the left bank of the Hororata River.

In many localities the brown coal beds have suffered considerable denudation, so that only a small portion of the coal seams is situated above the principal drainage line of the country; in others the beds have been preserved by more favourable circumstances, and rise several hundred feet above the watercourses near which they are situated.

There are three principal considerations, of which, in judging of the practical value of these coal-bearing strata, we ought not to lose sight, viz.: (1.) Quality of coal; (2.) Thickness of seams; and (3.) Extent of beds from which the coal can be obtained level free.

QUALITY OF COAL.

Of the three main localities where the coal seams are easily accessible, we must at once put the Hororata aside, as there the beds are only of small extent, and contain coal of inferior quality. Of the two remaining localities the Hawkins and the Selwyn, the brown coal beds on the right bank of the first-named river have been worked for years to a limited extent, through which we have become well acquainted with the character of the ground. Of the three sets of seams occurring there, those at present worked by Mr. John Jebson are the thickest, consisting of two seams of about two feet each, with the same thickness of shale between them. They consist of a brown coal of very fair quality, which is at least equal to that obtained from the principal beds of brown coal of Bohemia, which is so extensively worked and used all over that country, not only for household purposes, but also for stationary and locomotive engines. I may here observe that although coal of the carboniferous period is largely imported to Berlin from Silesia, Bohemian brown coal is nevertheless extensively used there also, as proved by German statistics.

QUANTITY AVAILABLE.

The second consideration—viz., extent of beds above water line of drainage channels—judging only from our present experience, is not so favourable near the Hawkins as in some other localities.

The hill sides, rising about 200 feet above the Hawkins, consist mostly of post-pliocene alluvium, so as to leave only a small portion of the coal beds level free. Of course, I only speak of the indications the former and present workings have afforded me; and it may be possible that if the drives are continued further into the hill the coal beds may rise so as nearly to reach the surface, and thus give us an altitude of nearly 200 feet, throughout which, of course, a larger quantity of coal for extraction would be available than we can expect at present, reasoning from the data before us.

The last locality under consideration is the Selwyn, where, in the Surveyor's Gully, one of its small tributaries, and close to the Canterbury Plains, seams of very good brown coal, about three yards in thickness, can be easily worked, and appear to be of quality superior to any other of the same beds, both north and south. Moreover, the quantity that can be obtained level free, according to my calculations, is about 3,000,000 tons in that neighbourhood. Thus, if no other considerations were to be taken into account, the Selwyn brown coal beds would, taken by themselves, offer the greatest advantage, both to the coal miner and to the public, but the existence of the second series (altered coal in isolated outliers, owing their preservation to the action of igneous rocks near them) must not be overlooked, as they will also afford coal of a superior quality, in more or less quantity, according to the size of the outliers.

The alteration of the brown coal, as shown in my report, has been of various degrees of intensity, according to the thickness, number, and size of the dolerite dykes and streams which are associated with it.

The coal beds in the Big Ben outlier are the least affected, still possessing the character of a true but excellent brown coal, whilst the seams in the Acheron assume quite an anthracitic nature.

The beds in the Kowai and the Upper Selwyn assume an intermediate structure resembling European and Australian coal of carboniferous age. Of the isolated patches the easiest of access, that of the Selwyn above Mount Misery, first claims our attention. It is the largest in size, has in its north-east corner been worked by Mr. M. B. Hart for the last few years, and now towards the centre Mr. H. P. Hill is just sinking a shaft for mining purposes on a large scale. From a calculation of the approximate area over which mining could be carried on with advantage in that locality, it appears that at least 1,500,000 tons of altered coal for household and steam purposes would be available, always assuming that the disturbance in the beds is not greater than the result of previous examinations would suggest to have taken place.

LINE OF COMMUNICATION.

Considering therefore that the most valuable portion of the unaltered and altered brown coal beds occur on and near the banks of the Selwyn, a railway constructed from the Rolleston Station on the Southern Railway line to the junction of the Surveyor's Gully with the Selwyn, would bring us to a central spot, whence the brown coal seams of the Surveyor's Gully, and on the banks of the Selwyn, as well as the altered beds on which Mr. Hart's and Mr. Hill's mines are situated, could be reached by a tramway.

This line would have many advantages, as it would pass over the waste lands of the Crown all the way, and thus could be cheaply constructed, whilst at the same time, excellent land would become opened for selection all along the line and its neighbourhood.

Moreover, a still larger amount of land could be made available by means of improving it by irrigation, for which the levels of the country and the existence of the debouchures of such rivers as the Hawkins, Wai-ani-wha, and Selwyn into the plains, would offer peculiar facilities.

I wish also to draw attention to the central position of the terminus of such a line being easily accessible to the inhabitants of the Hororata and upper Rakaia, as well as to those of the Hawkins and the Upper Waimakariri; and, if necessary, branch lines could be constructed in both directions in years to come from such a central locality.

There would be also another way by which Russell's Flat and the Kowhai (West Coast Road) could be reached—viz., by continuing the line up the Selwyn as far as Hart's Flat, then across the low saddle to Russell's Flat, and so on to the Kowhai, by which all the level country in that direction would have direct communication with Lyttelton and the other centres of population along the line, and by which also the timbered country of the Kowhai could be brought within reach. Another way for continuing the line would be to skirt the Malvern Hills from the central station, near the Selwyn, below the junction of the Surveyor's Gully, so as to reach Mr. Jebson's coal mines, and so on to the Kowhai. By these proposed lines, an easy market might be gained for the coal deposits and other natural products of the Malvern Hills for the benefit of the country.

REPORT ON THE CALEDONIAN MINE, THAMES GOLD FIELDS, BY CAPT. F. W. HUTTON, F.G.S., ASSISTANT GEOLOGIST.

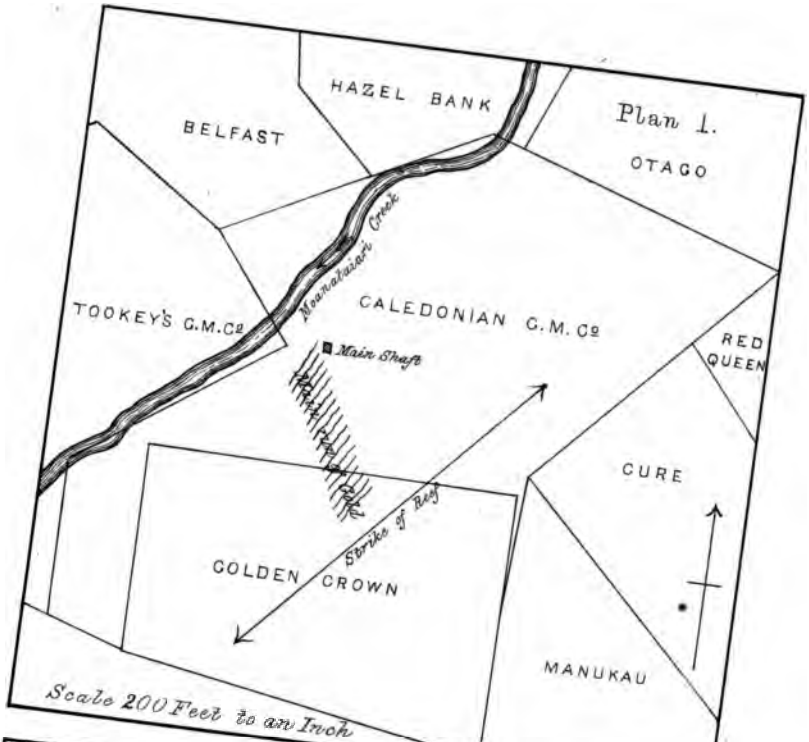
June 1871.

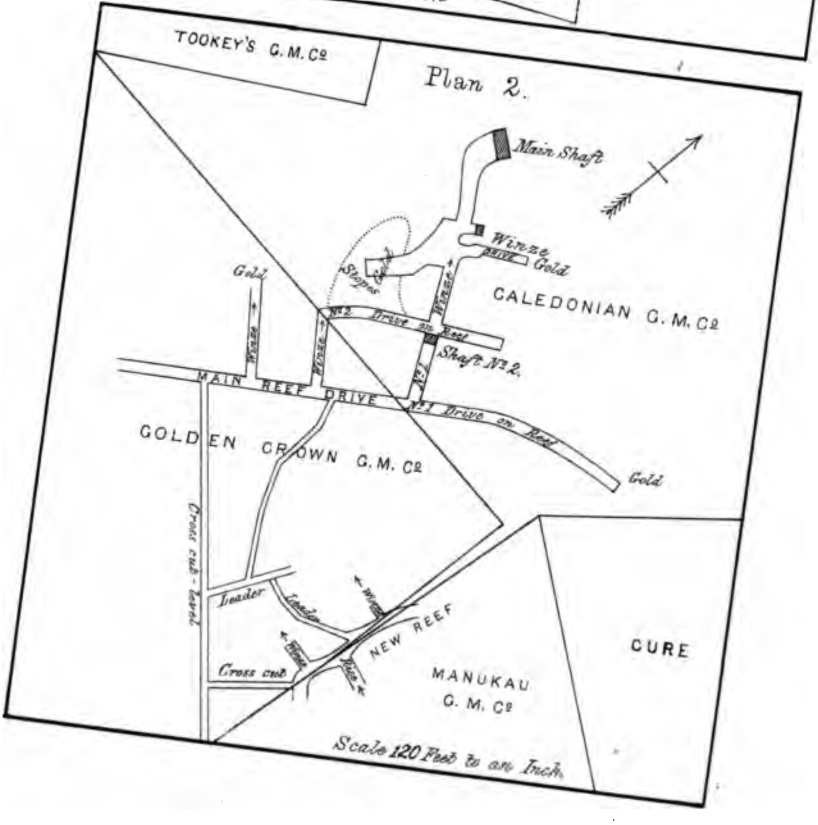
GENERAL DESCRIPTION.

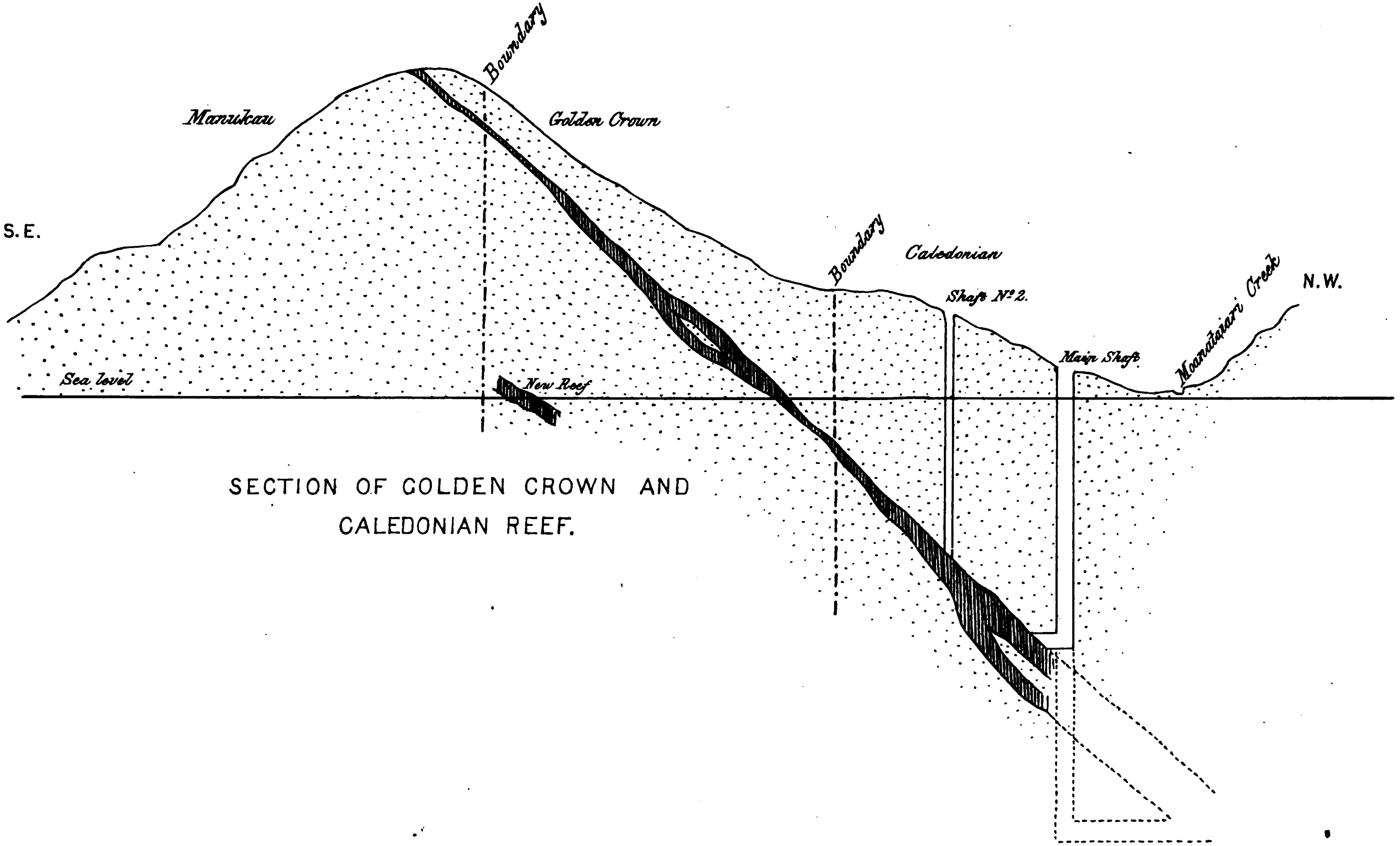
THE Caledonian Gold Mining Company's mine is situated near the spot where the Moanatairi Creek debouches on the alluvial plain on which Grahamstown is built. It comprises about three and a quarter acres of ground, partly on either bank of the Moanatairi from the Waiotahi. The reef is the same as that of the Golden Crown and Manukau mines, and underground communications have been established between all three. The strike of the reef is about N.E. by N., and its dip about 42° N.W. by W. At the west end, however, of the company's ground, as it approaches the Cure Claim, the strike gradually curves round to W. by N., the dip keeping the same angle of 42°. The mine is worked by two shafts, one below the other in the line of the dip, on the slope of the hill towards the Moanatairi. The main shaft is now about 180 feet below sea level, but is not yet down to the lode, which is reached by a short drive from the bottom of the shaft. It is proposed to sink the shaft another ten fathoms, and then put in another gallery, as shewn by the dotted lines in the section, in order to reach the lode at a lower level.

BED ROCK.

The surrounding country, or bed rock, has already been described in my second report on the Geology of the Thames Gold Fields. It is of a pale grey colour, and very hard when *in situ*, but on exposure to the air quickly turns white, and decomposes into clay. It is the same rock as that of which the chemical composition is given in the Geological Survey Report, 1868–9, p. 40, No. IV of table. It is essentially felspathic, and contains a large proportion of water of constitution. The analysis of a similar rock


Plan 1.
HAZEL BANK
BELFAST
OTAGO
Moanataiari Creek
TOOKEY'S G.M.Cº
CALEDONIAN G.M.Cº
Main Shaft
RED QUEEN
CURE
Strike of Reef
GOLDEN CROWN
MANUKAU
Scale 200 Feet to an Inch


TOOKEY'S G.M.Cº
Plan 2.
Main Shaft
Winze
Drive
Gold
Stopes
Gold
Gold
Winze
Winze
Winze
Nº2 Drive on Reef
Shaft Nº2.
Nº1
CALEDONIAN G.M.Cº
MAIN REEF DRIVE
Nº1 Drive on Reef
Gold
GOLDEN CROWN G.M.Cº
Cross cut-level
Leader
Leader
Winze
Winze
Rise
NEW REEF
Cross cut
MANUKAU G.M.Cº
CURE
Scale 120 Feet to an Inch.



SECTION OF GOLDEN CROWN AND CALEDONIAN REEF.

from the Kapanga Mine at Coromandel, given in the analyses attached to my first report on the Thames Gold Fields (Geological Reports, 1867), shews that this felspar contains potash.

The rock appears to consist of a quantity of small rounded grains of white felspar, embedded in a grey felspathic matrix, small crystals of iron pyrites are scattered through it, and generally it is intersected in all directions by small veins of quartz, but no grains of quartz nor flakes of mica are found in the rock itself. Dr. Hector has applied the name of "tufanite" to this rock. It is probably a metamorphosed tufa.*

THE REEF.

The lode when first worked in the Manukau Claim was from four to five feet thick, but contracted towards the boundary of the Golden Crown Claim; it then swelled out, in the middle of the latter claim, to ten feet, containing in the centre a "horse" about two feet thick. In descending towards the Caledonian claim, the lode gradually thinned out to about nine inches; it then began to make again, and was eighteen inches thick on the Caledonian boundary. Here it was poor in gold, but soon got very rich, and afterwards thickened out to about eight feet, keeping rich the whole way. Nearly opposite to Shaft No. 2, it suddenly widened to eighteen feet, a leader at the same place coming in from below. This widening was caused by the foot-wall dropping down, while the hanging wall carried on its former direction. Both walls are well defined, and a large "horse" of the tufa rock, which, however, contains gold, lying in between. At the time I visited the mine (June), the lode was supposed to be about twenty feet thick, but the foot-wall had not been reached. Just above this swelling out it was exceedingly rich.

The reef in the upper part of the Golden Crown has already been described (See Second Report on Thames Gold Fields, Geological Survey Reports, 1868–9, p. 29), as a band of rock infiltrated with silica, and containing nodules and veins of quartz, the walls only being distinguished from the bed rock by the absence of quartz in the latter. In the Caledonian, however, it is quite different, being more brecciated and cavernous, and the walls well defined. The reef is black, owing to the abundance of protosulphide of iron, while the bed-rock is pale grey. A clay parting also often occurs between the reef and either wall, owing to the decomposition of the rock by the percolation of water through the lode. The vacuities in the lode are irregular in shape, as if left between angular breccia, and are more or less filled with amorphous and crystalline quartz radiating inwards; the quartz is dark-coloured, almost black, and the crystals are invariably very small. Black angular masses, like pieces of bed-rock, are seen amongst it, and the gold does not penetrate these, but ends abruptly against them.

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* By the term "metamorphosed tufa," is meant a fragmented rock of igneous origin, that has undergone chemical change subsequent to its deposition, the variety *tufanite* acquiring special prominence from its being the matrix of the auriferous veins.—J. HECTOR.

The gold is found intimately mixed up with amorphous quartz, which sometimes occurs in large isolated, apparently concretionary masses, which often shew no gold on the outside, but when broken are found to be often more than half their bulk of the precious metal. It is, however, generally distributed through the lode, and often aggregated into bands, or irregular patches. In April last I saw a band of auriferous quartz in the mine, about six inches thick and ten feet long, so rich that, at several yards distant it looked of a pale yellow colour, something like a bar of yellow soap. The gold, however, is not spread uniformly through the reef, but is found in an irregular manner. The main run is about thirty feet in breadth, the gold dying out on both sides along the strike of the reef. This run has a direction of about N.N.W., or rather oblique to the dip of the lode, and gets richer or poorer at different depths, without any certain order.

Besides this main run, other patches, of from a few inches to a few feet, are found irregularly distributed, almost all of which seem to have a tendency to elongate in the direction of the dip of the reef, and some of these may, on further exploration, prove to be other runs more or less parallel to the main one.

New Golden Crown Reef.

A new reef has lately been discovered in the Golden Crown claim, below the old one, and dipping 45° W., with a thickness of about eight feet. Forty tons taken from this reef gave a yield of about 100ozs. This reef is like that of the Caledonian, but has a north and south strike. Its distance below the old one will, of course, vary, as they are not parallel, but in the centre of the claim the new reef is about 100 feet below the old.

Other Minerals than Quartz.

The minerals, other than quartz, associated with the gold, are iron pyrites, copper pyrites, stibnite, galena, and zinc-blende in considerable quantities, as well as small quantities of oxide of copper, oxide of silver, and probably sulphate of silver.

YIELD.

Up to the end of last February the Golden Crown Company had crushed 17,106 tons of stuff, from which they had obtained a yield of 59,541ozs. 14dwts. 6grs. (value £167,360 1s. 7d.) The Caledonian Company had, up to the end of May, crushed about 6,000 tons, with a yield of about 180,000ozs., thus making, exclusive of the Manukau Mine, a total of about 140,000ozs. from about 22,200 tons, or an average of 6¼ozs. per ton. During this time the Golden Crown has paid £120,000 and the Caledonian £350,000 in dividends, making a total of nearly half a million of money above cost of production from this one reef alone. The returns from the different mines in the field are not officially ascertained, but the appended extract from the local press afford the most reliable data available.

As the outcrop of the reef in the Manukau Claim was about 220 feet above the sea level, and the Caledonian shaft is 180 feet below the sea level, it follows that about 560 feet in depth of the reef have been explored and found to contain gold, although in varying quantities. During the whole of this distance no change in the nature of the rock has taken place, and there is no apparent difference which can be attributed to the influence of the sea level. By far the richest stone was taken out at about 150 feet below the sea, but this probably was in no way owing to the relative position.

DESCRIPTION OF PLANS.

In the accompany plans Plan I. represents the shape of the ground owned by the Company, and the position of the different claims around it. I have also shown on it the strike of the reef and the position of the main run of gold.

Plan II. is taken on a level in the Golden Crown Mine from the main reef along the cross cut, about fifty feet above sea level, to the new reef. The rest of the plan from the main reef to the shaft in the Caledonian Company's mine is on the inclined slope of the reef.

The section gives a general idea of the lie of the reef through the claims. It is not drawn to an accurate scale, but is tolerably correct.

YIELD OF GOLD ON THE THAMES GOLD FIELD FOR MARCH, 1871, 45,200 OUNCES.

[From the "Thames Advertiser."]

The yield, we may remark, is the highest ever produced by the field during any similar period.

Claim or Company.	Stone Crushed.			Amount of Gold.		
	Tons.	Cwt.	Lbs.	Ozs.	Dwts.	Grs.
Alburnia	70	0	0	155	10	0
All Nations	290	0	0	1,284	0	0
Ashley (tribute)	21	0	0	26	15	0
Alliance (Tapu)	60	0	0	*33	12	12
Berkeley Castle (tribute)	12	0	0	6	0	0
Better Luck	10	0	0	9	17	0
Bendigo Independent	17	0	0	23	10	0
British	6	10	0	8	13	0
Best Wrinkle	20	0	0	37	0	0
Beehive	4	10	0	6	4	0
Ballarat and Rising Sun	30	0	0	103	0	0
Caledonian	1,370	0	0	*32,437	9	0
City of Glasgow and Black Angel	90	0	0	21	12	0
Christmas Box (Coromandel)	10	0	100	35	15	0
City of London	42	0	0	41	0	0
Coromandel, sundries				40	0	0
Candlelight No. 1	47	0	0	148	0	0
City of Dunedin	70	0	0	82	0	0
Count Von Bismarck (Coromandel)	3	0	0	7	17	12
Cock-a-Doodle	40	0	0	34	0	0
Cape of Good Hope	10	0	0	8	5	0
Clyde and Tyne	8	0	0	4	15	0
Crystal Palace	6	0	0	*8	17	0
City of Hamburgh	6	0	0	6	0	0
City of Dunedin Extended	4	0	0	*1	9	12
Coulabah	10	0	0	11	0	0
Dixon's No. 1	130	0	0	213	14	0
Eveline	20	0	0	*13	13	12
Excelsior (Coromandel)	15	0	0	80	0	0
Eldorado (tribute)	62	0	0	146	0	0
Golden Anchor	18	0	0	18	0	0
Golden Crown	487	0	0	910	19	0
Giant (Coromandel	5	0	0	7	10	0
Great Britain and Brunswick	9	15	0	2	10	0
Globe	4	10	0	2	4	0
Gibralter	60	0	0	61	0	0
Harbour View (Coromandel)	12	0	0	71	6	0
Inverness (tribute)	52	0	0	174	0	12
Imperial Crown (tribute)	69	10	0	207	0	0
Indomitable	20	0	0	4	15	0
Junction	150	0	0	340	12	0
Kuranui (creek tribute	50	0	0	108	0	0
Kuranui Company	700	0	0	545	0	0
Kerry	4	0	0	1	18	6
Lady Bird and Hand of Friendship	750	0	0	277	0	0
Last Chance	13	10	0	5	0	0
Little Republic (Coromandel)	6	0	0	12	0	0
Long Drive	300	0	0	842	0	0
Moanatairi	897	0	0	944	14	0
McDonald's Lease	52	0	0	32	0	0
Morning Star	80	0	0	281	19	0
Montgomery Brothers	3	0	0	21	10	0

Claim or Company.	Stone Crushed.			Amount of Gold.		
	Tons.	Cwt.	Lbs.	Ozs.	Dwts.	Grs.
Multum in Parvo	20	0	0	25	10	0
Middle Star	2	0	0	25	0	0
Manukau	30	0	0	147	10	0
Mary Ellen	0	0	30	9	0	0
Moa (tribute)	41	0	0	18	18	0
New May Moon	60	0	0	*127	0	0
Nonpariel	345	6	8	869	12	12
Pride of York	9	0	0	20	16	0
Poverty and Charleston	50	0	0	38	0	0
Providence (tribute)	18	10	0	50	10	0
Pride of Karaka (tribute)	0	0	60	*45	11	2
Point Russell	81	5	0	23	10	0
Queen of Beauty	39	0	0	67	10	0
Red, White, and Blue	161	0	0	197	10	0
Royal Charter	40	0	0	16	0	o
Royal Oak (Coromandel)	15	0	0	51	0	0
Rover	12	0	0	8	10	0
Red Rose	4	0	0	3	0	0
Specimens at Spencer's	0	0	25	25	10	0
Sundries at Spencer's				25	11	0
Swedish Crown (Coromandel)	14	0	0	*34	12	0
Shotover	600	0	0	190	0	0
Sundries				1,000	0	0
Tookey's (tribute)	59	0	0	84	0	0
Tweedside (tribute)	16	0	0	21	14	0
Tapu Gold	30	0	0	23	0	0
Tokatea (Coromandel)	130	0	0	721	0	0
Te Kooti	1	15	0	2	10	0
Una	289	0	0	773	0	0
Union	79	10	0	132	8	0
Vale of Avoca	45	0	0	*97	12	0
Waitemata	350	0	0	291	0	0
Waiotahi (tribute)	5	0	0	4	0	0
West Coast	5	0	0	25	0	0
Wild Missouri	20	0	0	7	0	0
Total	8,790	13	9	45,200	11	8
February Returns	7,074	2	70	30,749	16	9
Increase in March	1,716	10	51	14,460	14	23

* Means that the quantity stated is in melted gold.

[The above returns show an average per ton on the whole quantity crushed during the month of March of 5ozs. 2dwts. 20grs.]

REPORT ON THE GEOLOGY OF THE COUNTRY BETWEEN BEDSTEAD GULLY AND GOLDEN GULLY, AND ON THE PERSEVERANCE GOLD MINE, BY CAPTAIN HUTTON, F.G.S.

25th August, 1871.

Rocks of the District.

The oldest rock found in this district is a dark blue laminated clay slate, fissile in its upper portions, but becoming more solid below. It is slightly cleaved and slightly contorted, and weathers into a dark coloured, almost black clay. Resting conformably upon this clay slate is a finely laminated felspathic slate, usually of a grey or greenish-grey colour, often in the lower portions with imperfect crystals of hornblende developed in the planes of the bedding. Occasionally it passes, especially in the upper portions, into a hard quartz schist, which is generally traversed by thick veins of white amorphous quartz. These slates decompose into a yellowish-white or reddish clay. Lying unconformably on the slates a small patch, of a coal formation, is seen in Sailor's and Gibbs' Gullies, at the southern extremity of the district. The lowest bed is a dark grey sandstone, in places passing almost into a slate, and containing numerous quartz veins. Above the sandstone is a bed of conglomerate, consisting chiefly of rounded quartz pebbles, but containing sometimes fragments of the slates. On the top are two beds of carbonaceous shale, containing thin seams and streaks of black glossy coal, in which obscure leaves of dicotyledonous plants are found; these two beds are divided by a stratum of quartz grit, about fourteen feet thick, and above the highest another bed of conglomerate is seen in places.

Above the coal formation, lies unconformably a thick bed of dark blue crystalline limestone, without fossils. The large deposit of white quartz pebbles, which forms such a striking feature in Golden Gully, could not have been deposited by any agencies at present at work. I believe them to be due to the degradation of the quartz schists which occur in the upper parts of the felspathic slates, and which must at one time have covered the whole district (see Section I.)

Geological Structure.

The geological structure of the district is not very complicated. A synclinal curve runs from between Sailor's and Gibbs' Gullies in a north and south direction, its axis inclining downwards to the north, thus throwing up the blue clay slates all along the southern boundary of the district, while the central and northern portions are covered by the felspathic slates (Section I.) The coal formation has partaken also in these movements, but it lies in an old hollow that had been previously eroded out from the slates, and is found partly on the blue clay slates and partly on the felspathic slates (Sections II. and III.)

The superincumbent limestone had not been formed when these movements took place, as it covers all the other rocks in a more horizontal position (Section III.) Its true dip, however, cannot be ascertained in the small portion coming into the district now under review, as it is much broken up, probably by the undermining action of water on the softer subjacent rocks.

On the west side of the syncline, over the central parts of the district, the rocks dip gently east, at angles of from 8° to 18°, but towards the south-west boundary, both in Sailor's and One-eye Gullies, the dip increases suddenly to 80° (Section IV.) On the eastern side of the syncline the dip appears to be pretty uniform from 40° to 50° W.

Besides this major north and south fold, minor folds in an east and west direction occur on the western, and perhaps, also, on the eastern side of of the syncline. These minor folds average about forty yards in length, and two yards in height at the Perseverance Claim (Section VI.), so that the lay of the rocks through the claim might be represented by a very flat corrugated iron roof.

The cleavage throughout the district is indistinct, but strikes N.E. and S.W., with a dip of from 35° to 65° N.W.

Position of Lode.

It is just along the line of junction between the blue clay slates and the felspathic slates, and following their line of bedding, that the quartz lode lies that is being worked for gold in the Perseverance and Decimal gold mines.

Perseverance Mine.

This mine is the only one at present at work in the district. It is situated on the eastern slope of Bedstead Gully, and contains twenty-one acres, from the head of the gully for about twenty-eight chains downwards.

The lode here varies from two and a half to six feet in thickness, and follows accurately the foldings of the rocks, the blue clay slates forming its foot wall, and the felspathic slates the hanging wall; no true glossy, clayey walls, however, are seen on either side. It consists of white amorphous quartz, generally with an angular and broken appearance, but it often occurs in good sized blocks. These blocks of quartz are in general not continuous, but lie packed in a matrix of felspathic slates, the lamination of which has quite disappeared. Sometimes the quartz fills the whole lode, forming a regular reef. This band, although disconnected, keeps an approximate parallelism between its two surfaces, and appears to me to be more regular, both in this respect and in its direction than the majority of those lodes which cross the bedding. The quartz is often geodic, or cavernous, and stained red by peroxide of iron, which has been formed from the decomposition of pyrites. The gold sometimes occurs embedded in the white amorphous quartz, but more generally on the surface, in dendritic or irregular shaped pieces and threads.

Associated with the quartz in the lode are considerable quantities of iron pyrites, and occasionally copper pyrites, and other ores of copper, in small quantities; no galena, blende, nor stibnite, have as yet been found in the lode. Clay-ironstone and hematite are found in places in considerable quantities, and are said to contain gold; they are generally seen in the upper part of the lode near the outcrop, and are probably derived from the decomposition of iron pyrites. Yellow mica is also not unfrequent in the lode. At about five feet above the lode, in the felspathic slate, is a band some five or six feet thick of zinc-blende and galena. In the lower part of this band the blende is bluish black, with a metallic lustre, while towards the upper part it is associated with galena, which is sometimes crystallised, and here it is of a pale yellow colour, and with a resinous lustre. It is possible that the lower portions may be only an intimate mixture of the two minerals, which, in the upper part of the band, are purer, and separate.

Whether this band of zinc-blende extends continuously for any distance it is at present impossible to say, as the drives in the mine follow the lode, and, except in three or four places, do not extend high enough into the overlying slates to determine the question. It was first discovered near the end of No. 3 drive, in the following manner:—While continuing the drive the lode was found to bear off to the right, and expecting, from former experience, that before long it would come back again (owing to the minor folds in the rock, as before explained), the manager continued the drive straight on; this, of course, made the drive pass above the lode, and when they approached the position of the lowest part of the fold, the drive was sufficiently high above the reef to penetrate the band of blende.

This blende has also been found at the bottom of the winze sunk on the reef from No. 3 drive, where again it has the same position of about five feet above the lode. In No. 1 drive, however, there are places driven through which appear to be high enough to cut the blende, but none is seen, neither can any be found along the outcrop of the lode, either in Bedstead or Kelly's Gullies. I am, therefore, inclined to think that the zinc will not be found in a continuous band, but in large, nearly horizontal, lenticular masses, thinning out in all directions.

The felspathic slates are very porous, readily absorbing water, while the underlying blue clay slates are almost impervious to it; nevertheless, the Perseverance workings, even the winze sunk from the lowest drive, are perfectly dry. I therefore suppose that the lode running in an inclined plane at the junction of the two rocks acts as a natural drain, and keeps the upper formation from becoming saturated with water, and perhaps it may be that the quartz and metals have been deposited from the water thus draining away.

In the present workings the dip of the lode near the surface is about 18° E. (true), but between Nos. 2 and 3 drives it began to flatten, and from here down to the bottom of the winze it has a dip of only 8° E. (Section IV.).

As the lode can be traced for a considerable distance down both Bedstead and Kelly's Gullies, I have no hesitation in expressing my opinion that it will extend continuously through the whole of the Perseverance Claim. Taking the moderate average of three feet as its thickness, this would give 5,000 tons of lode ground per acre, or say 100,000 tons in all. In other words, I might roughly estimate that twenty head of stampers could be kept constantly going with it for ten years.

From the report lately published by the directors, it appears that 432 tons have been crushed with a yield of 161ozs. 5dwts. of gold, or an average of nearly 9 dwts. per ton. At the last crushing, however, about 225 tons yielded the rate of 1¼ozs. per ton, and, in my opinion, the yield over the whole claim will not be less than ½oz. per ton. At present the battery consists of ten head of stampers, and a single stamp specimen battery, worked by a thirty horse-power turbine. The plant is an excellent one as far as it goes, but I should recommend that a Berdan be added for grinding the blanket washings, for it appears to me that without some means of working up the blanket washings, the blanket tables are useless.

The mine is now worked by levels driven in from the gully, but as the continuous character of the lode, and the absence of water in the mine may be considered as proved, I should recommend that an inclined shaft be put down on the lode just opposite to the battery, so that the turbine could be used for drawing up the stuff, and the mine worked by levels right and left from the shaft. If this were done, and the battery increased to twenty head of stampers, I think there is every reason to suppose that the mine would prove a very profitable concern.

With regard to the blende and galena I hardly know what to recommend, for it is well known that blende is looked upon as the worst enemy of the lead smelter. Perhaps the safest plan would be to ship a few tons to England, with the view of ascertaining its value, and the best process for smelting it; and if the report was favourable, it would then be time enough to ascertain the extent of the deposit.

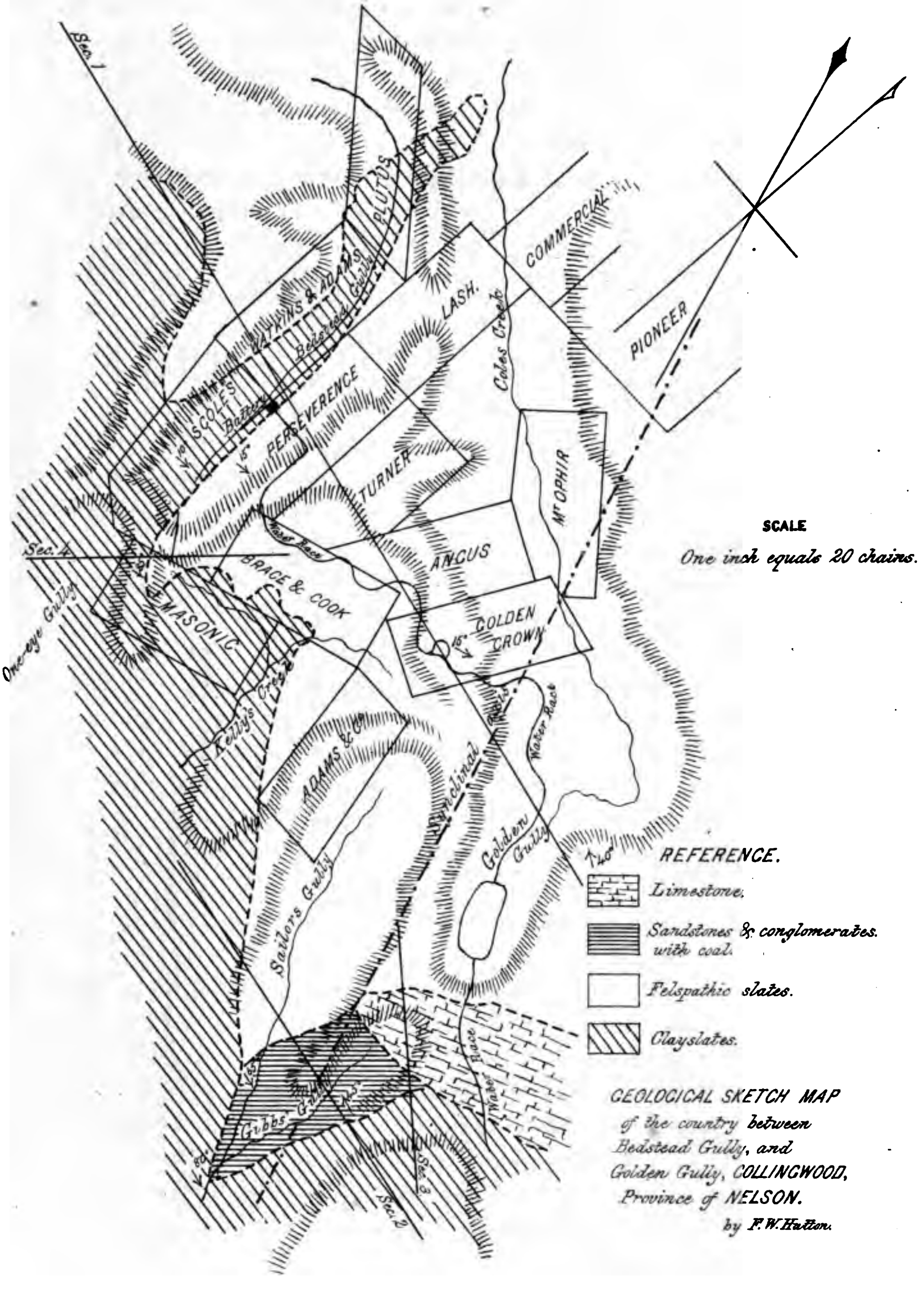
The late Mr. E. H. Davis, in his report on the Perseverance Mine, (*ante*, p. 134), describes the lode as occupying a fissure between the clay slates and felspathic slates, which has been caused by the movement of one or other of the two rocks, through a vertical space of twelve or fifteen feet. This movement, he says, was slightly diagonal, viz., 25° to the south of vertical.

I regret to be obliged to differ in opinion from Mr. Davis, but if the mine had been as extensively worked and as well surveyed when he was there as it was last July, he would, I think, have agreed with me that the differences in the dip were caused by the corrugations that I have bescribed, and not by the shifting or faulting of the rocks along an uneven fracture.

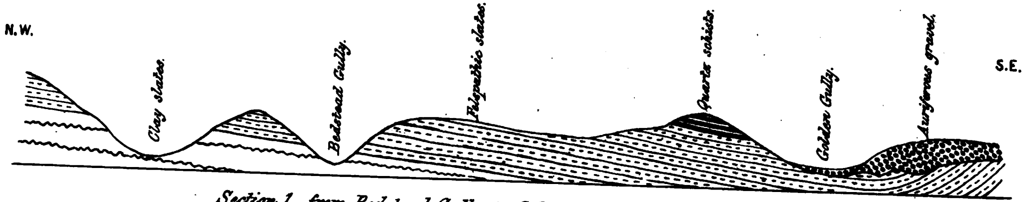
The general parallelism of the hanging and foot-walls of the lode, whatever may be the dip—the section at the head of One-eye Gully (see Sec. 4), where both the clay slates and the felspathic slates are seen to turn up suddenly from an angle of 15° to one of 85°, the lode turning up with them, and keeping its position between the two formations—and the all but physical impossibility of a sliding motion taking place along a fracture inclined only some 13° to the horizon, especially when that fracture was an uneven one—are, I think, quite sufficient proofs that Mr. Davis' view was erroneous.

No slate breccia is seen in the lode, but if it was an opening caused by the sliding movement of the opposite side of an uneven fissure, such would certainly be found. The brecciated appearance of the quartz cannot have been caused by the movement which is supposed to have caused the fissure, as the fissure must have been formed before the quartz could have been deposited in it. Moreover, the quartz, although apparently broken, is not really so, but owes its angular appearance, I believe, to seggregations from a number of nuclei at irregular distances from one another.

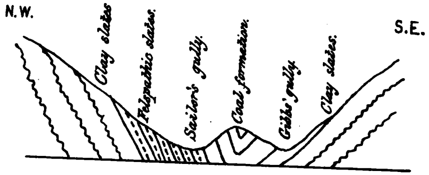
Neither can I endorse Mr. Davis' opinion as to the "remarkably promising" character of the copper "lode?" in the Pioneer Claim in Coles' Gully. This so-called lode is but a band of quartz schists occurring in the upper part of the felspathic slate formation, which here dips at an angle of 65° E. These schists are traversed in places by veins of quartz containing copper pyrites, but so irregular is their occurrence, and so small are the detached pieces of ore, that I do not think it could be worked in England, and feel sure that it would not prove remunerative in New Zealand.



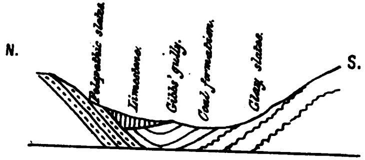
GEOLOGICAL SKETCH MAP
of the country between
Bedstead Gully, and
Golden Gully, COLLINGWOOD,
Province of NELSON.
by F. W. Hutton.



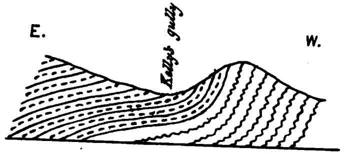
Section 1. from Bedstead Gully to Golden Gully.



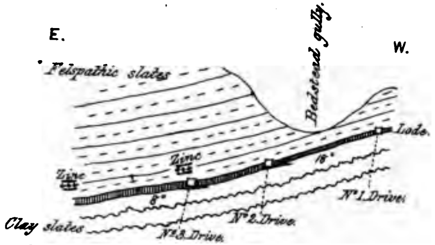
Section 2.



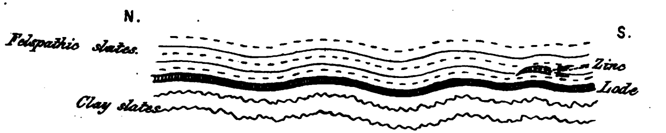
Section 3.



Section 4.



Section 5. across Lode in the Perseverance Mine.



Section 6. along the Lode in Nº 2. Drive.
Perseverance Mine.

REPORT ON THE COLLINGWOOD COAL MINE, BY CAPTAIN HUTTON, F.G.S.*

28th August, 1871.

THE coal mine near Collingwood is situated in the hills on the left, or western bank of the Aorere River, near its mouth.

The base of the hills is composed of clay slate, micaceous in places, dipping 40° N.W., near the incline, and 20° N.W., a little further inland. The highest point to which these slates reach, in this section, is about 600 feet above the level of the sea.

Upon them lie the coal measures, also dipping at an angle of 20° N.W. The lower part of this formation consists of a breccia formed of angular pieces of the lower slates, and pebbles of quartz; it also contains traces of the remains of plants. This breccia passes upwards into a thick bed of conglomerate, composed of large rolled pebbles of a dark blue submetamorphosed sandstone, of slate, and of quartz. Above this comes a complicated series of hard green sandstones, slaty rocks, and occasionally beds of grit. Among them are several beds of coal, the five lowest of which only are at present known, the upper part of the formation not having as yet been sufficiently explored.

The lowest known coal seam (1) is from three to four feet, with bands of slate in it about two or three inches in thickness. The next (2) is one and a half feet with many seams of shale, leaving not more than eight inches of good coal. The next (3) consists of two beds of coal, having thicknesses of fourteen and six inches respectively, separated by a band of shale four inches thick. A seam of good coal (4) from two feet eight inches to three feet in thickness comes next; it is sometimes divided by a band of shale two inches thick. The uppermost seam (5) is from three and a half to five feet in thickness, with a varying amount of shale.

No. 5 is the seam that was first found, and is the only one that has been worked at present, but No. 4 was being opened out at my visit, and is probably being started upon now.

In the sandstones and grits leaves of dicotyledonous plants, as well as obscure impressions of boughs, etc., are found. The coal contains occasionally pebbles of quartz, but no retinite or fossil gum.

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* See also, Report on the Pakawau Coal Field by Dr. Hector. Geol. Report, 1867, p. 19.

From the top of the lower waterfall the creek divides into two. The northern branch comes over a nearly vertical fall of 160 feet, and then sloping up, as shewn by the dotted line in the section. The southern branch rises at a very steep incline, and, at the position of the mine, is not far from the level of the northern branch; these two branches, therefore, cut off the coal seams on either side.

The mine is worked by galleries on the strike of the beds, from the level of the creek. The coal is brought out on an iron tramway, and passed down by a shoot, to the level of the top of the lower waterfall; it is then placed in trucks, which are taken along a tramway to the top of the incline by a horse, then lowered down the incline by a wire rope, and finally taken to the wharf by another horse.

It will be seen that this method of working the mine must soon come to an end; for as soon as the small portion between the level of the creek and the crest of the spur is worked out, either pumping and hauling machinery will be required, or else the mine will have to be opened by a gallery from the bottom of one or other of the water-falls, and so work it level free.

NOTES ON THE GEOLOGY OF THE HAWKE'S BAY DISTRICT.

BY DR. HECTOR.

THE term "Hawke's Bay Series" was applied by Professor Hochstetter to a group of "limestones, sandstones, and clay marls, replete with fossils belonging to the latest tertiary formation."

In the course of several journeys from Napier into the interior, and also down the valley of the Rangitikei to the West Coast, I have had an opportunity of observing this formation, and its relation on the one hand to the slate axis, which forms the main range in this part of the Island, under the names of the Ruahine and Kaweka Mountains; and in the other to the volcanic rocks which prevail in the Taupo district, and culminate, in altitude, in Ruapehu and Tongariro.

The accompanying sketch sections—first, from the coast opposite Napier in the north district, along the line of road up to the Runanga Hill, where the open plains covered with pumice-stone commence; and second, from the Kaimanawa Range south-west across the Valley of the Waikato at its source, and through Ruapehu—will serve to illustrate the relative position of the formations in the district.

The tertiary rocks to be referred to comprise three distinct groups:—

1. Sandy limestone, consisting of broken shells cemented together,

chiefly Pecten, Ostrea, and Waldheimia, with intercalated sand and clay beds, thickness about 700 feet. 2. Clay marls, with layers of pebbles and fossil shells, of the genera cardium, myadora, pectunculus, perna, maya, tellina, turritella, voluta, etc.; probable thickness, 1,000 feet. 3. Conglomerate and brown ferruginous sandstones, with irregular seams of coal. The last formation belongs to an earlier period than Nos. 1 and 2, as in some places the unconformability is evident.

The thickness of the sandstone formation is very considerable, probably exceeding 1,000 feet.

In the above enumeration neither the later tertiary drifts nor the superficial deposits of gravels resting on layers of drift wood, which form the Meanee plains, have been included, as they are of much later date, those last mentioned being alluvial deposits that have accumulated behind barrier ridges of shingle that were heaped up during a gradual subsidence of that part of the coast.

Between Cape Kidnapper and the Te Aute Hills the marls, conglomerates, and overlying limestones have a westerly dip of 10° to 15° under the valley of the Tukituki and the Meanee Plains, which therefore occupy a syncline.

In the section exposed along the coast south of Cape Kidnapper, the marls appear to expand into a much better developed formation than on the western side of the syncline, their lower part, probably, representing in part the sandstone and conglomerate beds that are in contact with the older rocks along the base of the mountains. At Bare Island and Cape Tunagain the marls form very bold cliffs about 600 feet high, and in continuing the coast section to the south, a still older formation of blue septaria clays, laminated shales, flag stones, and finally, hard sandstones of a light green color, mottled with red and yellow, appear on the coast near Akateo, where they are nearly vertical, but still dipping inland.

Sinde Island, on which Napier is built, belongs to the upper part of the formation, and occupies a central position in the trough, for at Petane, where the road to Taupo leaves the beach, the upper calcareous strata are dipping to the eastward.*

The section of the Hawke's Bay district, from this point to the commencement of the Taupo Plain at Runanga, is shewn in the upper section of the accompanying plate. The road at first follows a valley deeply cut into calcareous sandstones and marls, which rise steadily towards the interior, at an angle of about 10° for about eight miles, till they form a bold scarp 1,700 feet above the sea level, making the Mangapikopiko Range (*a. b. c.*) Westward of the above scarp, which can be traced borth north and south by the bold cliffs which face to the westward, the road rises from the river bed on to an undulating table land about 1,000 feet above the sea level, where the ferruginous sandstone and conglomerate reaches the surface.

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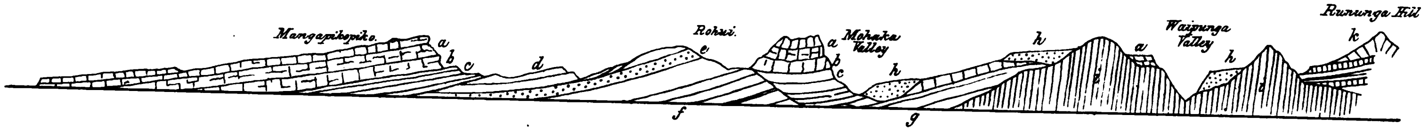
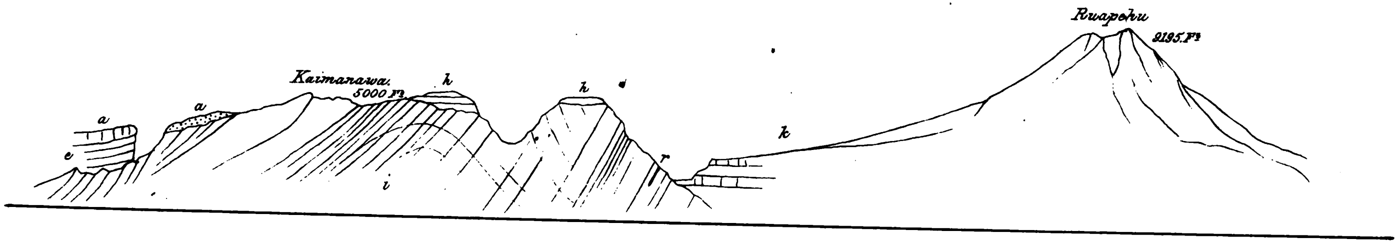
* Captain Hutton, in describing the artesian wells at Napier, has inferred that the upper limestones rest direct on the older rocks at that place, (*Trans. N.Z. Inst.*, Vol. III., Pl. XXVII., p. 251), on account of fragments of slate having been obtained in a boring near the town, not having been aware at the time that conglomerates containing slate occur in the underlying tertiary formation, and from which the fragments were probably derived.

These beds (*d. e.* and *f.*), are lost at Pohui, the Titiokura Range that is crossed before descending to the Mohaka Valley, being composed of the first beds (*a. b. c.*), the limestones forming the summit of the range 2,800 feet above the sea. The valley of the Mohaka, in this part of its course, lies in the strike of the strata, but in the section afforded by its steep, and in places precipitous banks, the sandstones of the lower formation are not exposed, the river flowing through a channel cut in the clay marls (*c.*), containing the usual and characteristic fossils of that formation. As the section thus exposed is at least 1,500 feet, we must suppose that the relation of the upper to the lower series is somewhat as represented, although the junction was not seen. On the terraces along this valley, pumice occurs in considerable quantity, as it does in all the rivers which take their rise in the interior, and have cut their way through the slate rocks of the main axis; but no pumice, or other volcanic rocks, occur under cirumstances that indicate their existence on the east side of the axis, until the opening of drainage channels, by the erosion of these deep valleys, through the hard slate rocks and the overlying tertiary formations.

On rising from the valley of the Mohaka towards the N.W., the tertiary strata rapidly thin out, and beyond Te Harotu the slate is at the surface, forming steep and sharp-topped ridges, with outlying patches of the upper tertiary strata (*a*). The road, a few miles after passing Te Harotu, descends to the valley of the Waiponga, which is excavated in slate and indurated sandstone, of the same character as other parts of the main range. Extensive deposits of drift pumice fringe the valley, forming high steep terraces (*h*). At about forty miles from the eastern sea coast, the point is reached where the volcanic plains of the interior commence, in which the Waiponga, and other rivers which take their rise and after flowing for some distance in wide flat valleys, bounded by horizontal floes of trachyte lava, mark the line of junction by a succession of cascades as they drop into the contracted valley that leads them through the slate region. Beyond Runanga the open country



SECTION OF HAWKE BAY DISTRICT.



SECTION OF KAIMANAWA RANGE, & RUAPEHU.

commences as a series of level plains of pumice drift, with ridges of trachyte lava and tufas, and extends to Taupo Lake. These later formed volcanic deposits completely envelope and conceal the tertiary rocks on the west side of the range in the line of section which has been examined.

The second section illustrates the relation which the volcanic rocks of Tongariro and Ruapehu have to the expansion of the slate axis which constitutes the Kaimanawa range. These volcanic rocks are probably the most recent of any in New Zealand.

No marine tertiary rocks are exposed on the western slope of the Kaimanawa Mountains, but towards the south-east, in the depression between them and the west side of the Ruahine Range, the tertiary limestones occur, forming a wide belt of open grassy country, and are continued to the west as a succession of scarps, or edges, encircling the volcanic zone, and dipping to the S.W. Within a few miles of Mr. Birch's Station, in the valley of the Rangiheki, the tertiary strata can be observed to thin out against the mass of slate (*a*) rock at an altitude of 2,800 feet above the sea level. Gravel beds occur, with false bedded layers, and other characters that lead to the belief that there is preserved at this place, the original shore line of the tertiary sea, the calcareous strata having been deposited amoug a group of slate islands, now represented by the Kaimanawa, Kawaka, Ruahine, and Tararua Mountains. Since the period of this deposit there must have been a great inequality in vertical movement, as the same strata, which round the last-mentioned range only reach to less than 1,000 feet above the sea, are in the north found at more than twice the altitude; yet these irregular movements must have taken place during a very late geological period, and while the immense masses of volcanic matter which envelope the country to the north were accumulating. The tertiary beds above described as belonging to the Hawke's Bay series, notwithstanding the very recent character of the fossils, contain no trace of volcanic matter, so that the eruption of the central volcanoes must have commenced after their deposition was completed.

The character of the formations was specially examined, with the view of determining whether any evidence exists that would lead to the discovery of gold, especially in the Kaimanawa district.

The valleys on the west slope of the Kaimanawa Range, where it bounds the Upper Waikato, opposite to Tongariro, are extremely rugged, and the rock formation is fully exposed along the banks of the streams, shewing an irregular succession of sandstones and slates probably belonging to the upper Palæozoic formation, and dipping at a high angle to the south-east. Among these strata there are bands of blue cherty slate, with small irregular veins of quartz, stained with iron and manganese, which, so far as yet tested, are non-auriferous. Several places were observed where this quartz crops out in the rocky banks of the creek, containing a considerable quantity of iron pyrites, which mineral, discovered under such circumstances, generally contains minute traces of gold, but does not necessarily indicate the presence of an auriferous quartz reef.

The Kaimanawa Range is comparatively flat-topped and clear of vegetation above 4,000 feet in altitude, where the same rocks are exposed as those seen in the valleys, but I was much surprised to find a thin stratum of pumice drift in patches where it has been preserved in hollows on the summits of the highest ridges. The exposed surface of the slate rock is much decomposed, and, above the limit of the vegetation, is broken into sharp splinters. Similar veins of white quartz to those in the gully were observed to intersect the slates; and, throughout the depth of at least 3,000 feet, to which these rocks are laid bare by the streams, no decided alteration in the character of the formation was observed.

In the streams flowing west from the Kaimanawa Range, cascades, about 100 feet high, mark the junction of the slate rocks with the volcanic formation, which here consists of lava streams from Tongariro. This line of junction can be traced round the foot of the range towards the north, the flanking spurs, composed of volcanic rock, increasing in width in that direction, so that they at last form a distinct subsidiary range, where the Tauranga River descends from the main range to Taupo Lake. The Tauranga River is reported to flow through seven gorges in this outer range, each of which is formed by a hard rock, termed "granite" by the prospectors, but which is probably trachyte-porphyry. In this part of the river, I was informed by a prospector, that he frequently obtained the "color," especially above the gorges, but that, on following the river into the slate country, in the upper part of its course, he never obtained any specks of gold in the wash.

On examining the streams in the outer range, I found what diggers would term a favorable "red and blue wash," in which we obtained a great deal of black sand, but did not succeed in finding any gold. The "wash," which is a coarse gravel, with clay intermixed with oxide of iron, contained, besides fragments of the common slate and sandstone of the ranges, a tough green slate rock, with fine veins of quartz, green and red trachyte-porphyry and quartz.

Prospecting parties fitted out from Hawke's Bay have now prospected the sources of the Rangitikei, which lie between the Kaimanawa and the Kotupu range, and are still engaged in examining the dip between the Kotupu and Kaweka ranges, which is drained by the Tararuarua and Ngararuru rivers.

The Tararuarau gorge, by which that river escapes to the east, through the main mountain axis of the Island, appears to have been formed by a great dislocation of the range at this point, causing a drop on the eastern side of at least 800 feet. This is distinctly shewn by the sudden break and change in the altitude at which the same beds of tertiary limestone are found, within a few miles of horizontal distance, on the east and west sides of the mountains. On the east side the appearance presented by the isolated patches of tertiary strata, broken and disturbed by ridges of slate rock which have been thrust through them, naturally suggests extensive, though not necessarily sudden dislocations, and recalls to mind the singular hills which occur further south, in the Wellington province, called the Taipos, which are formed of the same tertiary strata upheaved in vertical beds that project sometimes 1,400 feet above the general level.

The existence of such dislocations—affecting the structure of the range, and, perhaps, in a few spots, bringing within reach more deeply seated rocks than would otherwise be found at the surface—has a peculiar interest in relation to the prospect of discovering metalliferous veins on the eastern side of the Ruahine Range, which district is intersected by deep gullies, the sides of which expose sections of tertiary sands and marlstones, containing marine shells, to a depth of over 1,000 feet.

The denuded surface of these marine strata is again covered by a deposit of coarse drift gravel, which has been distributed from the Ruahine Ranges during the gradual excavation of the water-courses, consequent on the elevation of the land in the post-tertiary period. In this gravel or drift, which appears to be formed altogether of such rocks as compose the ranges, an auriferous pebble was found by Mr. Lyon, and had it consisted merely of quartz containing gold, it would be a difficult task to search for its original site; but the specimen, fortunately, had a portion of the containing rock or original wall of the reef attached to the quartz. This rock proves to be a very characteristic form of syenite, a rock allied to granite, and which has not hitherto been detected in this part of New Zealand, though abundant in the South Island.

If this rock occurs in the Ruahine Range, it will be easily distinguished from the slates and sandstones, and should any prospector be fortunate enough to find it, he may conclude that he is not far off the line in which there would be the greatest chance of mineral veins.

Many years since, Mr. J. Coutts Crawford discovered a dyke of hornblende rock, which is allied to syenite, on the coast, south of Castle Point, not far south of the Taipos I have already alluded to. He also submitted a series of the specimens he had collected in the Wellington province to the Rev. W. B. Clark, the veteran geologist of New South Wales, who pronounced one specimen obtained in the Rimutaka to be granite. Subsequent investigation showed that Mr. Clark was misled by the appearance of the small specimen submitted to him, and that when examined *in situ* the rock is really an altered sandstone. It is, however, not improbable that the alteration of the sandstone may indicate the near approach to the surface of granite, or other highly metamorphosed rock, and that some point may yet be discovered where such rocks are actually exposed, as they frequently are in the mountains of the western district of Nelson. To some extent this view is supported by the circumstance, that the gold which is obtained near Wellington is always associated with a blue friable slate in contact with hard masses of this altered sandstone. This blue slate is full of fine reticulated veins of quartz and other minerals, and though I think there can be no question that it is the matrix of the fine scaly gold obtained, yet, notwithstanding the many attempts that have been made, no decided auriferous reefs have yet been discovered in it.

I would strongly recommend that the attention of prospectors should be more directed to ascertaining whether there is gold in the wash drifted down by the streams than to a random search for reefs. In a slate country which has been subjected to such extensive denudation as the Kaimanawa and Ruahine Ranges, gold, if present, must be found in the gravels of the streams. On all gold fields, the discovery of reefs followed long after that of alluvial diggings; and even at Coromandel and the Thames, where the district has not been subjected to extensive superficial denudation, it was the alluvial gold obtained in the creeks that first directed attention to the reefs.

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Geological Survey of New Zealand.

REPORTS

OF

GEOLOGICAL EXPLORATIONS

DURING 1870-1,

WITH MAPS AND SECTIONS,

JAMES HECTOR, M.D. F.R.S.,
DIRECTOR.

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